2.01.13

In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met by the contractor even after modification and/or replacement but are achieved within the Acceptable Shortfall Limit as specified at clause 3.00.00 of this sub-section, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 3.00.00 of this sub-section. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following (at Employer's discretion):

(i) **For Category-I Guarantees**

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Liquidated Damages. The liquidated damages for shortfall in performance indicated in clause 3.00.00 of this sub-section shall be levied separately for each unit. The rates indicated in clause 3.00.00 of this sub-section are on per unit basis. The liquidated damages shall be pro-rated for the fractional parts of the deficiencies. Such Liquidated Damages shall be deducted from contract price. The performance guarantees coming under this category shall be called 'Category-I' Guarantees.

(ii) **For Category-II Guarantees**

Reject the equipment / system/ plant and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category-II' Guarantees. Conformance to the performance requirements under Category-II is mandatory.

(iii) **For Category-III Guarantees**

Reject the equipment /system / plant and recover from the Contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the Employer. Such damages shall, however be limited to the cost of replacement of the equipment(s)/system(s), replacement of which shall remove the deficiency so as to achieve the guaranteed performance. These parameters/capacities shall be termed as "Category-III" Guarantees.

**3.00.00** **AMOUNT OF LIQUIDATED DAMAGES (LD) APPLICABLE FOR CATEGORY-I GUARANTEES**

The rate of liquidated damages and acceptable shortfall limits for different Category - I guarantees shall be as under and such liquidated damages shall be deducted from the Contract Price.

| Sl.No | Guarantee | Rate of Liquidated Damage (LD) | Acceptable Shortfall Limit with LD |
|---|---|---|---|
| i) | **Steam Generator Efficiency**<br>For shortfall in guaranteed Steam Generator efficiency in percentage points under conditions stipulated in **clause 6.01.00 (i) and (ii)** of this Sub-Section and elsewhere in this specification at : | | |
| | a. 105% TMCR (VWO) unit load | US $ **295,534/-**<br>(US Dollar Two hundred ninety five thousand five hundred thirty four only) for every 0.1% point shortfall in guaranteed efficiency. | (-) 0.5% points from the guaranteed efficiency |
| | b. 100% TMCR (800 MW) unit load | US $ **1,125,845/-**<br>(US Dollar One million one hundred twenty five thousand eight hundred forty five only) for every 0.1% point shortfall in guaranteed efficiency. | (-) 0.5% points from the guaranteed efficiency |
| ii) | **Steam generator capacity**<br>For shortfall in the guaranteed steam generating capacity in T/Hr at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet (with any combination of mill working as per Employer's choice), the coal being fired from within range specified | US $ **648,697/-**<br>(US Dollar Six hundred forty eight thousand six hundred ninety seven only) for every 1 T/hr short fall in steam output from the guaranteed value. | (-) 1.00% of guaranteed steam generator capacity |
| iii) | **Feed water pressure required at Economizer inlet (at FW terminal point)**<br>For increase in feedwater pressure from the guaranteed value at Feed water terminal point near Economiser inlet for main steam flow corresponding to 100% TMCR (800 MW ) Unit Load | US$ **82,255/-**<br>(US Dollar Eighty two thousand two hundred fifty five only) for every 1 $Kg/cm^2$ (abs) increase in Feed water pressure guaranteed at Feed water Terminal near Economiser inlet. | (+) 5kg/cm2 (absolute) from the guaranteed value |

| Sl.No | Guarantee | Rate of Liquidated Damage (LD) | Acceptable Shortfall Limit with LD |
|---|---|---|---|
| iv) | **Reheater attemperation spray water flow**<br>For every 1 (one) T/Hr increase in spray flow over guaranteed value while firing design coal and maintaining rated RH outlet steam temperature at100% TMCR (800 MW) unit load | US$ **132,873/-**<br>(US Dollar One hundred thirty two thousand eight hundred seventy three only) for every 1 (One) Ton/hr increase in spray water flow over guaranteed value at 100% TMCR (800 MW) unit load. | (+) 20% of guaranteed reheater spray water flow. |
| v) | **Coal Pulverizer wear parts warranty**<br>Life of coal pulverizer wear parts in hours of operation. | To be calculated as per **clause 10.00.00** of this Sub-Section | (-) 500 hours |
| vi) | **Auxiliary Power Consumption**<br>For increase in the auxiliary power consumption in KW guaranteed as per the requirements of **clause 6.01.00 (vii)** of this Sub-Section at :<br>100% TMCR (800 MW) unit load | US $ **2,258/-**<br>(US Dollar Two thousand two hundred fifty eight only) for every KW increase in the power consumption from the guaranteed value. | (+) 1% of the guaranteed auxiliary power consumption |

**NOTE:**

i) Each of the liquidated damages specified above shall be independent and these liquidated damages shall be levied concurrently as applicable.

ii) If the contract currency is other than US dollars, then the liquidated damages shall be in equivalent amount in contract currency based on Bill selling exchange rate of State Bank of India prevailing on the date of award of contract.

iii) All these liquidated damages for short fall in performance shall be deducted from the contract price as detailed in accompanying General Conditions of Contract (GCC)/ Special Conditions of Contract (SCC)

iv) Contractor's aggregate liability to pay Liquidated Damages (LD) for failure to attain the functional guarantee shall not exceed twenty five percent (25%) of the Contract Price.

v) The LD values and acceptable shortfall limits are applicable for per unit basis.

**4.00.00 SPECIFIC AND LIMITING REQUIREMENTS FOR STEAM GENERATOR EFFICIENCY**

4.01.00 Guaranteed Steam generator efficiency shall be calculated as per the requirements of BS EN 12952-15:2003 (by loss method) and as per stipulations of Clause 9.00.00 of this Sub-Section.

4.02.00 The guaranteed efficiency quoted by the Bidder shall comply with following limiting parameters with design coal firing :

| | |
|---|---|
| a. Excess air at economizer outlet at 100% TMCR load) | 20% (min.) |
| b. Corrected flue gas temperature at air preheater outlet (at 100% TMCR) | 125 degree C or as predicted by the Bidder whichever is higher |
| c. Unburned fuel at all guaranteed efficiency load at 100% TMCR load | 1.0% (min.) |

Bidder/Contractor to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests for performance predictions/ guarantees etc. if the values considered by the Bidder/Contractor for parameters indicated at a), b) & c) above are lower than those specified above.

4.03.00 For the purposes of guarantees the ambient air temperature and relative humidity shall be taken as 27 degree Celsius and 60% respectively.

4.04.00 Unless otherwise specified, the guarantees shall be based on design coal firing with coal/ ash analysis as given in Table-1, Sub-Section-V of Part-A of Technical Specification.

**5.00.00 AUXILIARY POWER CONSUMPTION (PA)**

The unit auxiliary power consumption shall be calculated using the following relationship.

$P_a = P_u + T_L$

$P_a$ = Guaranteed Auxiliary Power Consumption.

$P_u$ = Power consumed by the auxiliaries of the unit under test.

$T_L$ = Losses of the transformers supplied by bidder based on works test reports.

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating auxiliaries under this package. The auxiliaries to be considered shall include but not be limited to the following :

**UNIT AUXILIARIES (to be considered for calculating Pu)**

(a) Mills.

(b) PA Fans.

(c) FD Fans.

(d) ID Fans.

(e) Air Heaters.

(f) Coal Feeders.

(g) Steam Generator Startup Water Recirculating Pump (if in operation)

(h) Seal Air Fans.

(i) Lube oil pumps for fans, Air heaters, Mills, etc.

(j) Scanner air fans.

(k) Pressurising pumps of fuel oil system

(l) DM Cooling Water Pumps of ECW System

(m) Summation of Power consumption of one instrument air compressor, one Air drying plant and one service air compressor

(n) Gas Recirculation fan (if applicable)

(o) Compressor of Mill Reject System.

- 50 % of power consumption of the working compressor for (2x800 MW)
- 66 % of power consumption of the working compressor for (3x800MW)

(p) Power consumption of any other continuously operating auxiliaries for unit operation at different guarantee point loads.

**Note :** The bidder shall furnish a list of equipments to be covered under auxiliary power consumption, which shall be subject to Employer's approval.

**6.00.00 GUARANTEES UNDER CATEGORY-I**

6.01.00 **The Performance Guarantees which attract Liquidated Damages (LD) are as follows :**

(i) Efficiency of the Steam Generator at 105% TMCR (Valve wide operation unit load) with 27 degree Celsius ambient temperature and 60% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air. (To be demonstrated as per clause 9.00.00 of this sub-section). The guaranteed efficiency shall be based on GCV of coal.

(ii) Efficiency of the Steam Generator at 100% TMCR (800 MW unit load) with 27 degree Celsius ambient temperature and 60% RH, while firing the design coal, at rated steam parameters, rated coal fineness and rated excess air. (To be demonstrated as per clause 9.00.00 of this sub-section). The guaranteed efficiency shall be based on GCV of coal.

(iii) **Steam Generating Capacity**

Steam generating capacity in T/hr of steam at rated steam parameters at superheater outlet & rated steam temperature at reheater outlet(with any combination of mills working as per Employer's discretion) with the coal being fired from within the range specified in Table-1, Sub section V, Part A, Section VI.

(iv) **Feed water pressure required at Economiser inlet (at FW terminal point)**
Guaranteed Feed water pressure at Economiser inlet for main steam flow corresponding to 100% TMCR (800 MW unit load) shall be demonstrated.

(v) **Reheater attemperation spray water flow**

The following shall be guaranteed and tested:

Reheater Spray flow while firing design coal and maintaining rated RH outlet steam temperature at 100% TMCR (800 MW unit load).

(vi) **Coal Mill Wear Parts Warranty**

Life of coal pulveriser wear parts, in hours of operation, for the entire range of coal characteristics specified. (to be demonstrated as per clause 10.00.00 of this sub-section).

(vii) **Auxiliary Power Consumption**

Auxiliary Power Consumption at 100% TMCR (800 MW) unit load.

The total auxiliary power consumption for all the steam generator auxiliaries, Equipment cooling water pumps, Mill Reject Handling system, compressed air system etc. required for continuous unit operation at 100% TMCR (800 MW unit load) under rated steam conditions and with ambient air temperature of 27 degree Celsius & RH of 60%, shall be guaranteed in line with the requirements stipulated in clause 5.00.00 of this sub-section.

**Note:** Power consumption of each of the pump/fan/compressors/coal pulverizer /heater etc. wherever mentioned shall be measured with its own drive.

**7.00.00 GUARANTEES UNDER CATEGORY-II**

7.01.00 **The Performance Guarantees, conformance to which are mandatory are as follows :**

7.01.01 **NOx emission**

Contractor shall guarantee that maximum total NOx emission from the unit shall not be more than 260 grams of NOx (from thermal as well as fuel) per giga joule of heat input to the boiler during the entire operating range of steam generator for the range of coals specified.

The emission shall be measured during steam generating capacity test. The bidder shall furnish the methodology of measurement and demonstration of variations w.r.t. load up to 50% of total load.

**8.00.00 GUARANTEES UNDER CATEGORY-III**

The parameters/capabilities to be demonstrated for various systems/ equipments shall include but not be limited to the following:

8.01.00 **Noise**

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in Part-C of Section-VI of the Technical Specification.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m

horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar, shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

8.02.00 **STEAM GENERATOR AND AUXILIARIES**

(i) **Coal Pulverizer capacity at rated fineness**

Performance testing shall be conducted on coal pulverizers toward establishing their guaranteed capacity meeting the specification requirement. Corrections may be applied for the variation in coal characteristics i.e. HGI & Total Moisture of test coal with respect to specified design coal.

Capacity demonstration test shall be carried out for the following conditions:

(a) The Contractor shall demonstrate capacity output on one coal pulverizer (of Employer's choice) of each Steam Generator for establishing its capacity at 100% mill loading, at rated pulverized coal fineness with specified design coal with new set of grinding elements.

(b) Further, Contractor shall also demonstrate capacity output on four coal pulverizers (of Employer's choice) of each Steam Generator, not less than the 90% of guaranteed value of (a) above, at 100% mill loading with the originally installed grinding elements in nearly worn-out condition or at the end of guaranteed wear life of grinding elements, whichever is earlier.

Capacity test as mentioned at a & b above shall be demonstrated at the following conditions occurring simultaneously during testing:

| | |
|---|---|
| Rated pulverised coal fineness | i. not less than 70% through 200 mesh and |
| | ii. not less than 99% through 50 mesh screen |
| Test Coal | Any available coal from the specified range |

In case the Contractor successfully demonstrates the guaranteed capacity of coal pulverizers as stated above, remaining coal pulverizers of corresponding steam generator will also be considered to have successfully met the above capacity guarantee requirement. However, in the event of any of the coal pulverizers not meeting the guarantee test, all the coal pulverizers of corresponding steam generator will have to be tested by the contractor to demonstrate guaranteed capacity.

During the demonstration of the mill capacity output, manufacturer's operating instructions will be followed and mill will be operated with the specified range of coals without any such readjustment that requires a shutdown of the mill or reduction of the load and/or any replacement of any mill wear parts.

For the purpose of testing to demonstrate the capacity, if HGI (grindability) and total moisture vary from those given in coal characteristics, the above pulverizer measured capacity shall be corrected using the capacity correction curves furnished by the Contractor and approved by the Employer. HGI versus coal pulverizer capacity curve shall be furnished for HGI variation upto a value above which the capacity remain constant.

(ii) **No fuel oil support shall be required above 30% BMCR**

Contractor shall guarantee that oil support for flame stabilization shall not be required beyond 30% of BMCR load when firing the coals from the range identified. The Contractor shall demonstrate that with any combination of mills/ adjacent mills in service (to Employer's choice) the Steam Generator does not require any oil firing for stable and efficient boiler operation at and above 30% BMCR loads.

(iii) **Capability while firing upto 30% imported coal**

Contractor shall demonstrate the capability of Steam generator and its auxiliaries while firing upto 30% imported coal (indicated in Table-5,Sub-section-V,Part-A,section-VI) blend with coal as indicated in Table-1 ,sub section-V ,Part-A of Section-VI for atleast 72hrs as specified in clause no. 1.03.01 (e), sub section-II:M-1, Part-B of Section-VI.

(iv) **Run back capabilities**

Refer Sub-Section-II M1, Part-B, Section VI of Technical Specifications.

(v) **Rate of change of load and sudden load change withstand capability**
Refer Sub-Section-II M1, Part-B, Section VI of Technical Specification..

(vi) **Furnace Exit Gas Temperature (FEGT)**

The Contractor shall conduct a comprehensive thermal performance test (TPT) (on one unit only). Through such TPT the Contractor, by indirect measurement, shall demonstrate that the Furnace Exit Gas Temperature (FEGT) does not exceed the specified maximum temperature limit, with coal pulverizer combinations to Employer's choice and all other requirement in line with sub-section-II:M-1, Part-B of Technical Specifications. The demonstration shall be done by backward calculations method, after having measured/tested/calculated the economizer outlet gas temperature (average), excess air (average), unit heat load (based on turbine flow and reheater flow), characteristics of coal being actually fired during testing, heat absorption in different stages of heat transfer equipments (based on steam/water temperature and pressure measurements) etc. FEGT for the specified design and worst coals shall be calculated using the measured FEGT (with test coal) as above and using computer modeling technique for necessary conversion of the results to the specified design and worst coals. The FEGT demonstration using computer modeling technique shall involve following steps:

(a) Development of a computer field model (FM) (backward) using above measured/computed field data. This will be used to calculate the surface effectiveness factor (SEF) for each of heat transfer banks including furnace water walls with test coal.

(b) The above field model shall have to be validated by various tests (loads, coal pulverizer combination etc. with test coal) to ensure SEFs for each bank are consistent (within ±5%) for all tests.

(c) Using above SEFs, for each heat transfer bank contractor's original boiler design model will be changed to make it DARLIPALI STPP Stage-I specific.

(d) The validity of the above model shall be checked for each test by feeding the test coal both from backward direction FM and the calibrated "DARLIPALI STPP Stage-I Specific" model as per step-(c) above. The model validity is established if the results for flue gas temperature profile in the boiler, zonal assumptions etc. are identical in both the 'BACKWARD' and 'FORWARD DIRECTION'.

(e) The validated "DARLIPALI STPP Stage-I Specific" model shall have "Fuel Switching" capability i.e. it shall be able to appropriately vary the furnace absorption with changes in the coal properties. Validation of the above fuel switching capability will also have to be established to the satisfaction of NTPC.

(f) Having established and demonstrated FUEL SWITCHING capability, the contractual FEGT can be demonstrated by using the SITE SPECIFC calibrated model as per step-(d) and plugging in the specified coal(s).

The detailed procedure and the correction curves for the above test shall be to Employer's approval.

(vii) **Steam Temperature Imbalance**

The Contractor shall demonstrate that at SH and RH outlets (in case of more than one outlet) the temperature imbalance between the outlets does not exceed 10 deg C under all loads including transients.

(viii) **Air Preheater air in leakage**

Contractor shall demonstrate that the air-heater air-in-leakage and maximum drift in air leakage do not exceed the guaranteed or specified value (whichever is lower) as per sub-section-II:M-1, Part-B of Technical specifications. Above requirement needs to be complied with recirculation of flue gas from downstream of ESP.

8.03.00 **Power Cycle Piping**

Actual hanger readings under cold and hot condition (at rated parameters) to match with those of design cold and hot hanger readings for MS/CRH/HRH/HP & LP bypass piping system.

8.04.00 **Passenger & Goods Elevator :** Over load tests, travel and hoist speed checks.

8.05.00 **Mill Reject System**

Continuous effective discharge and conveying at the rated capacity of the mill rejects without spillage or blockage in the system.

8.06.00 **Equipment Cooling Water System**

(i) Capacity, head & power consumption of all the pumps with the respective job (own) motors to be demonstrated at shop. For the pumps which are included under "Unit Auxiliaries for calculation of Pu" as defined elsewhere the power consumption value (at rated duty point) during shop testing shall be considered for computation.

## VOLUME – II B

## SECTION – C2

## SPECIFIC TECHNICAL REQUIREMENTS

## ELECTRICAL SPECIFICATION

## SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

### 1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

1.1 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure–I to Section – C [Scope of Work (Electrical)].

1.2 Make of various equipment/ items in the scope of bidder shall be to approval of owner during detailed engineering stage without any commercial implications.

1.3 Bidder shall furnish all AC as well as DC loads required for the system at different voltage levels (eg. 415V AC, 240 V AC, 220 V DC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.

1.4 All electrical equipment shall be suitable for the power supplies, fault levels and climatic conditions indicated in project information enclosed with the specification.

1.5 All drawings, data sheets, Quality Plan, calculations, test reports, test certificates, etc. shall be submitted during detailed engineering stage as per formats enclosed. The same shall be subject to approval without any commercial implications.

1.6 Technical requirements shall be as per specifications listed in Clause 4.1, 4.2 & 4.3 below.

### 3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:

a) A copy of this sheet “Electrical Equipment Specification for MILL REJECT SYSTEM and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp.

b) Electrical load requirement in the load data format.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

### 4.0 LIST OF ENCLOSURES

4.1 Electrical scope between BHEL & vendor (Annexure-I).
4.2 Load data format (Annexure-A).
4.3 Technical spec. for Motors.
4.4 Technical spec. for Cabling
4.5 Technical spec. for LT Power, Control & Instrumentation cables.
4.6 Technical spec. for Junction box, Glands & Lugs.
4.7 Motor datasheet-A
4.8 Datasheet-C (Motors, cables & cabling)
4.9 List of test for motors.
4.10 Quality plans for motors.

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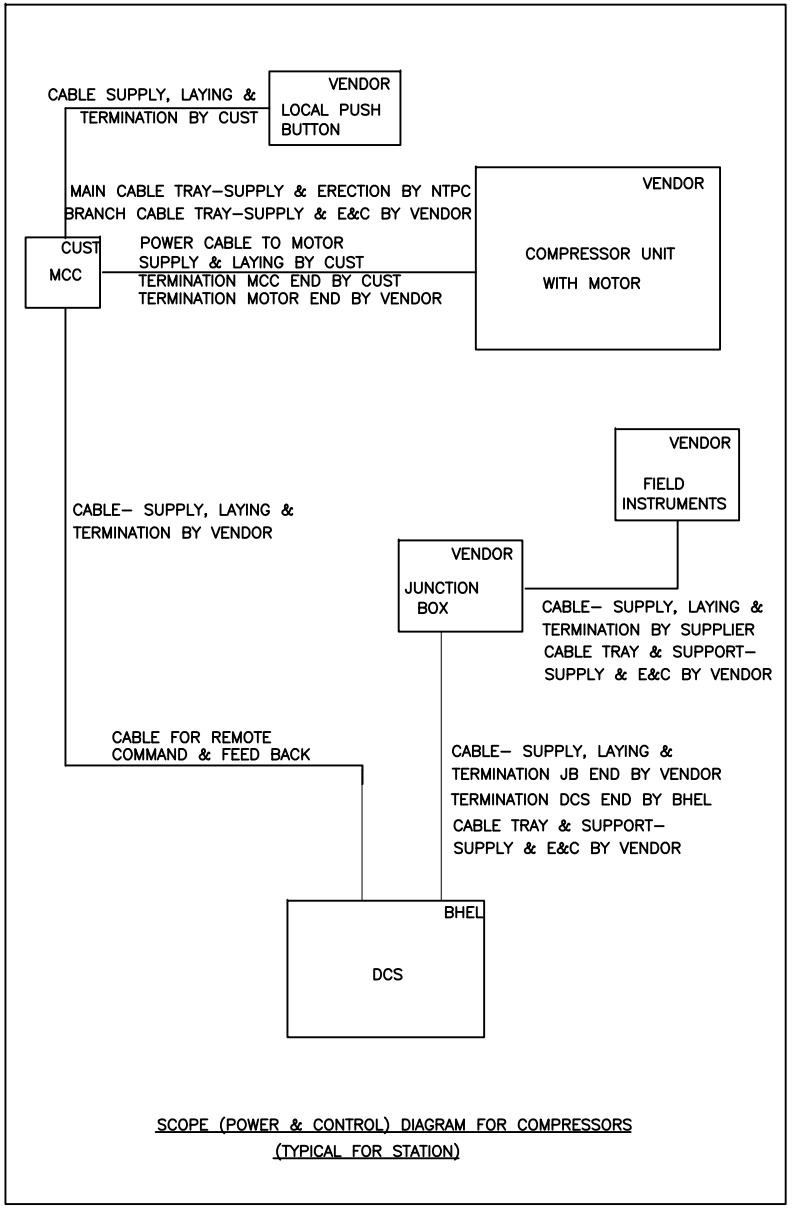
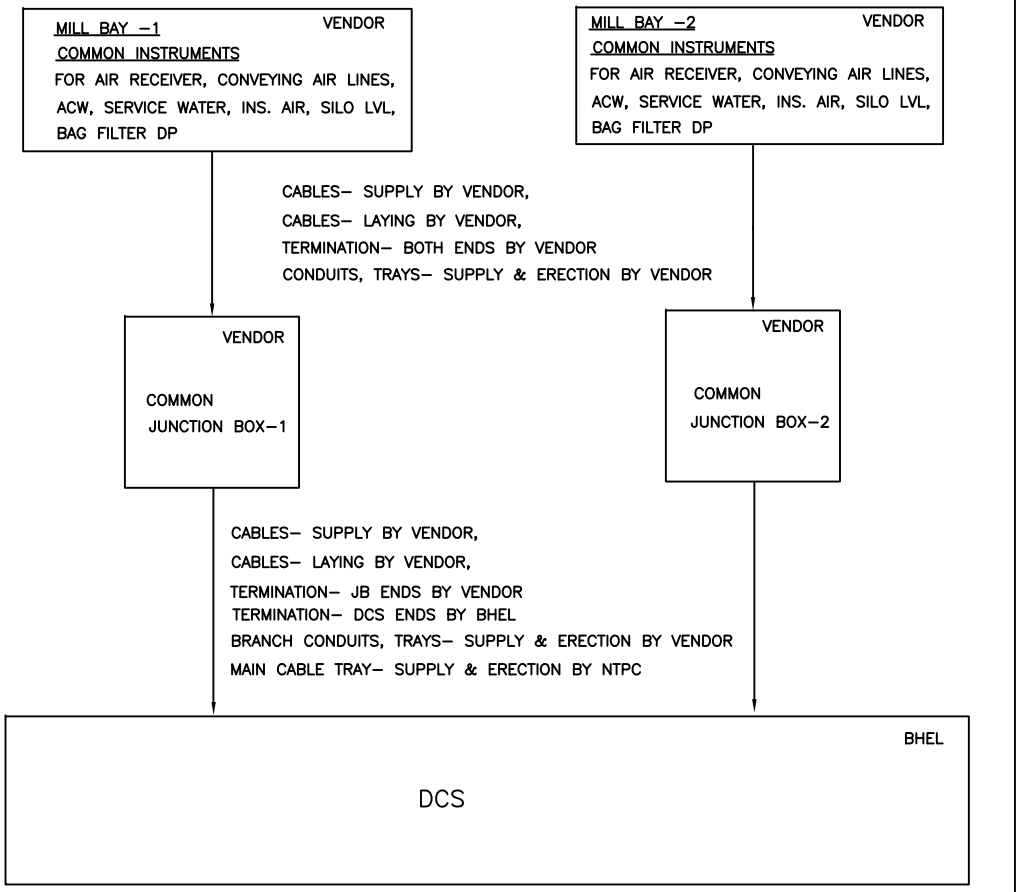



SCOPE (POWER & CONTROL) DIAGRAM FOR COMPRESSORS
(TYPICAL FOR STATION)




SCOPE (POWER & CONTROL) DIAGRAM FOR COMMON INSTRUMENTS OF MRHS
(TYPICAL FOR EACH UNIT)

LEGEND:

SCOPE OF SUPPLY

EQUIPMENT

MILL REJECT HANDLING SYSTEM
FOR BTG CONTRACTS

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

| DEPT CODE | | NAME | SIGN | DATE |
|---|---|---|---|---|
| | DRN | | | |
| | DESN | | | |
| | CHD | | | |
| | APPD | | | |

SUB–CONTRACTOR

TITLE: SCOPE (POWER & CONTROL) DIAGRAM

DEPT. | SCALE | BHEL DRG NO :

SIGN | DATE

SHEET 1 OF 2 | REV 00

SIZE–A2

FILE NO :

REV. 1 | DWG. NO.

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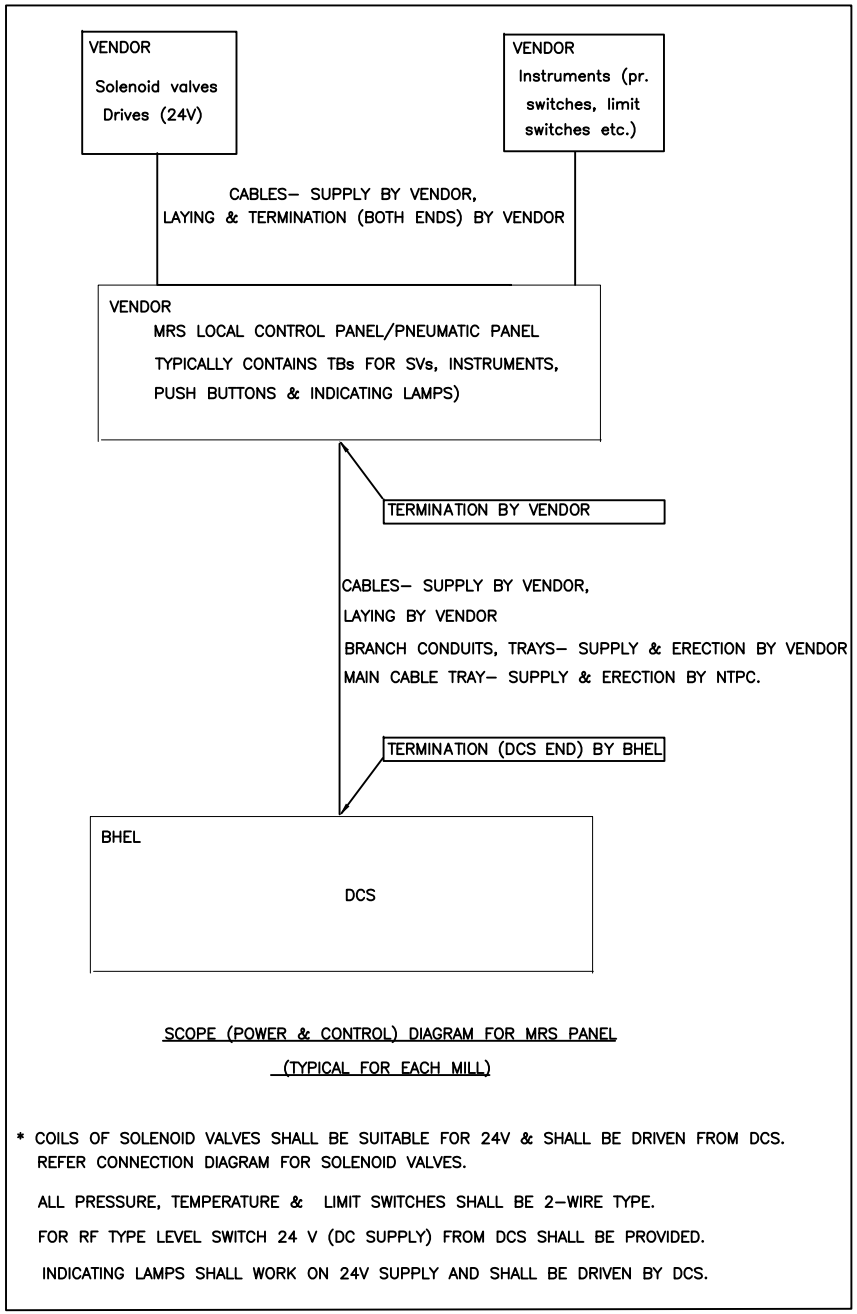
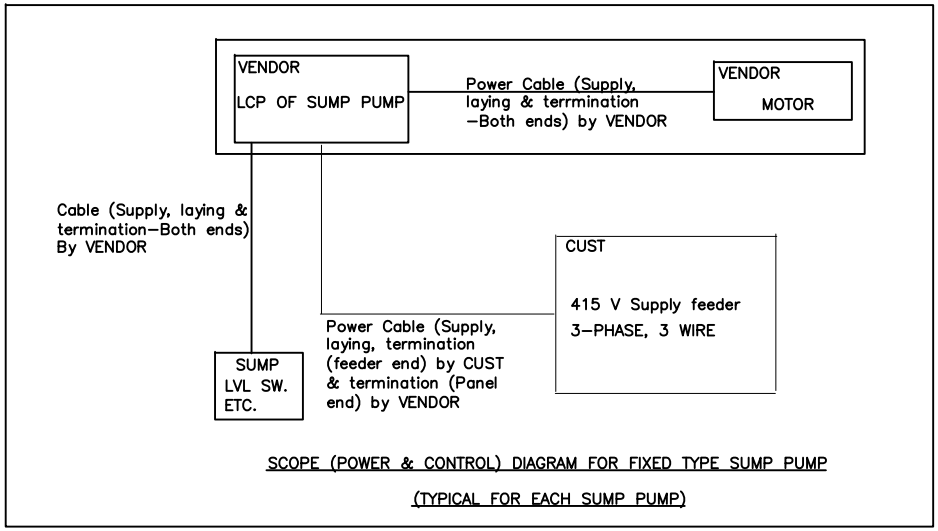
ALL INTERCONNECTING DIAGRAMS SHALL BE PREPARED BY VENDOR.
LUGS/ GLANDS FOR JBS, PANELS, MOTORS & INSTUMENTS – BY VENDOR



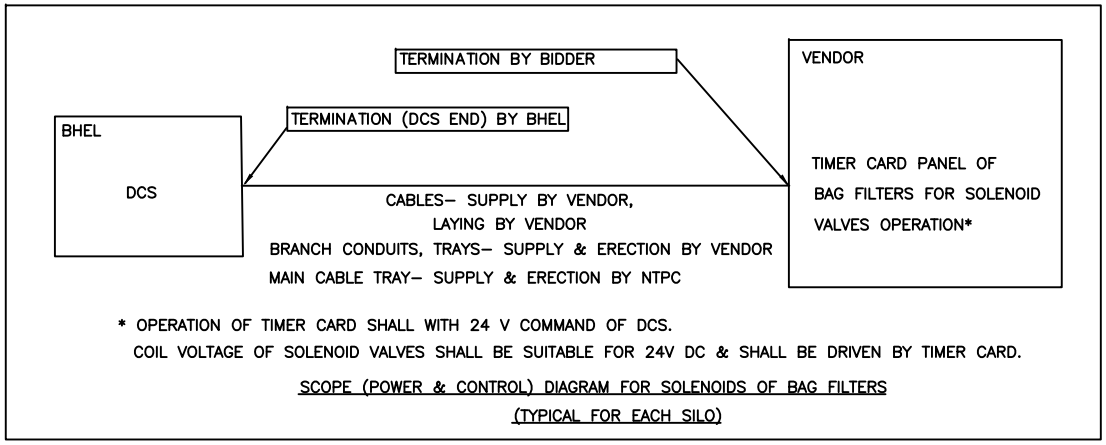

SCOPE (POWER & CONTROL) DIAGRAM FOR MRS PANEL

(TYPICAL FOR EACH MILL)




SCOPE (POWER & CONTROL) DIAGRAM FOR FIXED TYPE SUMP PUMP

(TYPICAL FOR EACH SUMP PUMP)




* OPERATION OF TIMER CARD SHALL WITH 24 V COMMAND OF DCS.
COIL VOLTAGE OF SOLENOID VALVES SHALL BE SUITABLE FOR 24V DC & SHALL BE DRIVEN BY TIMER CARD.

SCOPE (POWER & CONTROL) DIAGRAM FOR SOLENOIDS OF BAG FILTERS

(TYPICAL FOR EACH SILO)

* COILS OF SOLENOID VALVES SHALL BE SUITABLE FOR 24V & SHALL BE DRIVEN FROM DCS.
REFER CONNECTION DIAGRAM FOR SOLENOID VALVES.

ALL PRESSURE, TEMPERATURE & LIMIT SWITCHES SHALL BE 2–WIRE TYPE.

FOR RF TYPE LEVEL SWITCH 24 V (DC SUPPLY) FROM DCS SHALL BE PROVIDED.

INDICATING LAMPS SHALL WORK ON 24V SUPPLY AND SHALL BE DRIVEN BY DCS.

Vendor shall furnish main cable route drawing indicating the vendor's actual tray requirement during detailed engineering.

MILL REJECT HANDLING SYSTEM

FOR BTG CONTRACTS

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

| DEPT CODE | | NAME | SIGN | DATE |
|---|---|---|---|---|
| | DRN | | | |
| | DESN | | | |
| | CHD | | | |
| | APPD | | | |

TITLE: SCOPE (POWER AND CONTROL) DIAGRAM

DEPT. | SCALE | BHEL DRG NO :

SIGN | DATE

SHEET 2 OF 2 | REV 00

SIZE-A2

FILE NO :



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Annexure-A

## STANDARD FORMAT FOR ELECTRICALFEEDER LOAD LIST

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | KKS code as in vendor drawing | Description of feeder | Rating (KW/A) | Supply type | Unitised /Station | Normal / Emergency | Feeder type | Running Mode | Recommended cable size | Location Coordinates | Remarks |
| | | | | | | | | | | | |
| GUIDE LINES TO FILL THE FORMAT | | | | | | | | | | | |
| Column No. | Legend | Designation | Description | | | | | | | | |
| 1 | S. No. | 1,2,3 | Serial Number | | | | | | | | |
| 2 | KKS code as in vendor drawing | - - - | Unique kks of the Equipment | | | | | | | | |
| 3 | Description | - - - | Description of the bidders Equipment | | | | | | | | |
| 4 | Rating | | Name plate Rating in kW or Amps at 50 deg C | | | | | | | | |
| 5 | Supply type | 11 KV 3 ph AC / 3.3 KV 3 Ph AC / 415 V 3 Ph AC / 220 V DC / 240 V AC UPS / 240 V AC Non -UPS | | | | | | | | | |
| 6 | Unitised/Station | U | Unit(U) is applied for each unit. | | | | | | | | |
| | | S | STN(S) is applied for common equipment load. | | | | | | | | |
| 7 | Normal / Emergency | N | Normal Supply | | | | | | | | |
| | | E | Emergency Supply(Emergency supply i.e DG supply) | | | | | | | | |
| 8 | Feeder type | U | Unidirectional Motor feeder | | | | | | | | |
| | | B | Bidirectional Motor feeder | | | | | | | | |
| | | H | Heater feeder | | | | | | | | |
| | | S | SFU(switch fuse feeder) | | | | | | | | |
| 9 | Running Mode | W | Working | | | | | | | | |
| | | S | Standby | | | | | | | | |
| 10 | Recommended cable size | -/-/-/-/- | Recommended Incoming power cable size in: No of runs/no. of cores/ Size in mm2/Al or Cu/ PVC or XLPE | | | | | | | | |
| 11 | Location | | Location of the Equipment in coordinates row & columns as per layout | | | | | | | | |
| 12 | Remarks | | Any other relevant information | | | | | | | | |
| Notes: | 1) Electrical Load list shall be submitted as "MS Excel" sheet also in addition to that in pdf as per the format given above. | | | | | | | | | | |
| | 2) Each Row shall contain data of Only One equipment / load, i.e., if there are two numbers of the same equipment, they shall be indicated in two different rows with unique description & tag number. | | | | | | | | | | |

## 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 :

| | |
|---|---|
| (a) 11kV, 3.3 kV | +/- 6% |
| (b) 415/240V | +/- 10% |
| (c) 220 V DC | -15% to +10%. However the nominal continuous DC power supply shall be 240V. |

1.06.00 The voltage level for motors shall be as follows :-

| | |
|---|---|
| a) Upto 0.2KW | : Single phase 240V AC / 3 phase 415V AC |
| b) Above 0.2KW and upto 200KW | : 3 phase 415V AC (Except for motor of ACW and DMCW pump which shall be fed from 3.3 KV) |
| c) Above 200KW and upto 1500 KW | : 3.3 kV |
| 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 for contractors equipment and systems shall be under the contractor scope.

1.10.00 Degree of Protection

Degree of protection for various enclosures as per IS:4691, IEC60034-05 shall be as follows :-

| | | | |
|---|---|---|---|
| i) | Indoor motors | - | IP 54 |
| ii) | Outdoor motors | - | IP 55 |
| iii) | Cable box-indoor area | - | IP 54 |
| iv) | Cable box-Outdoor area | - | IP 55 |

**2.00.00 CODES AND STANDARDS**

| | | | |
|---|---|---|---|
| 1) | Three phase induction motors | : | IS:325, IEC:60034 |
| 2) | Single phase AC motors | : | IS:996, IEC:60034 |
| 3) | Crane duty motors | : | IS:3177, IEC:60034 |
| 4) | DC motors/generators | : | IS:4722 |
| 5) | Energy Efficient motors | : | IS 12615, IEC:60034-30 |

**3.00.00 TYPE**

3.01.00 **AC Motors:**

a) Squirrel cage induction motor suitable for direct-on-line starting.

b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be **Premium Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30.

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**

(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

(b) Whenever the basis for motor or driven equipment 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 equipment under entire operating range including voltage and frequency variations. |
| | ( c) For BFP motors starting MVA shall be restricted to 70 MVA. |
| **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.

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 | 11 KV motors shall be offered with Separate Insulated Connector(Elastimould or Equivalent make) as per IEEE 386. The offered elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds. |
| 7.10.00 | 3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Employer shall provide termination kit for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. 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. |
| 7.11.00 | The spacing between gland plate & centre of terminal stud shall be as per Table-I. |
| 7.12.00 | 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. |
| 7.13.00 | 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. |
| 7.14.00 | For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box. |
| 7.15.00 | 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.<br>(a) Below 110KW : 10.0<br>(b) From 110 KW & upto 200 KW : 9.0 |

| | |
|---|---|
| | (c) Above 200 KW & upto 1000KW : 10.0<br><br>(d) From 1001KW & upto 4000KW : 9.0<br><br>(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.

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.

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

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

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. 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**

**The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only**

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors ( in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip .
5. Temperature rise test .
6. Momentary excess torque test.
7. High voltage test .
8. Test for vibration severity of motor.
9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)
10. Test for degree of protection and
11. Overspeed test.
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.

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.

**TABLE - I**

**DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS**

| **Motor MCR in KW of** | **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 |

## CABLING, EARTHING & LIGHTNING PROTECTION

**1.00.00** **CODES AND 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 work shall be carried out as per the following standards/ codes as applicable.

IS:2309, IEEE:142, IEEE-80, IS:1255, IS:3043, DIN 46235.

**2.00.00** **REQUIREMENTS**

2.01.00 The complete cable support system shall be supplied and installed for the entire work is in the bidder's scope. The system shall enable proper laying of all power, control, instrumentation and telephone cables, and shall provide necessary mechanical protection, ventilation and segregation for them as per latest engineering practices and cable manufacturers' recommendation .The cable installation shall be carried out as per IS:1255. All hardware and anchoring arrangement shall be included. All steel members shall be hot dip galvanized.

# 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). |

**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 |

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. |
| 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: |

(a) Rated current of the equipment

(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

(c) Short circuit withstand capability

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.

(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

Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

a) Variation in ambient temperature for cables laid in air

b) Grouping of cables

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.

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.

**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 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 |
| | 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)

## 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.

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 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 as per IS: 5831 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.

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue and Black

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 consecutive 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 :

(a) Cable size and voltage grade - To be embossed

(b) Word 'FRLS' at every 5 metre - To be embossed

(c) Sequential marking of length of the cable in metres at every one metre. - To be embossed / printed.

The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible. For EPR cables identification shall be printed on outer sheath.

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 Control cables shall be sized based on the following considerations:

(a) The minimum conductor cross-section shall be 1.5 sq.mm.

(b) The minimum number of spare cores in control cables shall be as follows:

| No. of cores in cable | Min. No. of spare cores |
|---|---|
| 2C, 3C | NIL |
| 5C | 1 |
| 7C-12C | 2 |
| 14C & above | 3 |

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.

**3.00.00 CONSTRUCTIONAL FEATURES**

3.01.00 **1.1 KV Grade Control Cables**

Control Cables shall have stranded copper conductor and shall be multicore PVC insulated, PVC inner-sheathed, armoured / unarmoured, FRLS PVC outer-sheathed conforming to IS:1554. (Part-I).

3.02.00 **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 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.

**4.00.00 TESTS**

4.01.00 **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 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.

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. | Wrapping test | For aluminium wires / formed wires only |
| 7. | Resistance test | |
| 8(a). | Mass of zinc Coating test | For GS wires/formed wires only |
| 8(b). | Uniformity of zinc coating | For GS wires/formed wires only |
| 9. | Adhesion test | For GS wires/formed wires only |
| c) | **For PVC insulation & PVC Sheath** | |
| 9. | Test for thickness | |
| 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)

## 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. |