# TECHNICAL SPECIFICATION
*for*

# ACSR (MOOSE/ BERSIMIS/ ZEBRA) & AAC (BULL) CONDUCTOR

**SPECIFICATION NO: TB-XXX-316-019;**
**REVISION: 03**
**DATE: 12.09.2018**

## BHARAT HEAVY ELECTRICALS LIMITED
**TRANSMISSION BUSINESS GROUP**
**NOIDA, UP (INDIA) – 201305**

| | Prepared by | Checked by | Approved by |
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| Name | Dileep Shukla | SK Shukla | Aruna Gulati |
| Signature | 12/09/18 | 12/09/18. | |
| Date | 12.09.2018 | 12.09.2018 | 12.09.2018 |

# INDEX

# SECTION - I

# SPECIFIC TECHNICAL REQUIREMENTS

# ANNEXURE-A
# COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION

The bidder shall confirm compliance to the following by signing and/or sealing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.

2. There are no deviation(s) with respect to specification other than those furnished in the 'schedule of deviations'.

3. Only those technical submittals which are specifically asked for in Notice Inviting Tender (NIT) to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as a part of offer.

4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.

5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature

## ANNEXURE-B
## SCHEDULE OF DEVIATION/ CONCESSION/ CHANGE REQUEST

Bidder shall list out all technical potential deviation (s)/ concession(s)/change request(s) along with clause with respect to technical specifications.

| Sl. no. | Page no. | Contract requirement with clause no. | Potential deviation (s)/concession(s)/ change request(s) | Reason(s) / Justification(s) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Bidder's Stamp & Signature

## 1.0 PURPOSE

This specification is intended for finalization of rate contract between BHEL TBG and Bidder. Standard technical detail as indicated in the specification shall be agreed upon between BHEL TBG and bidder. Project specific technical details shall be made available to the bidder along with project specific material requirement.

## 2.0 SCOPE

2.1 Design, manufacture, inspection and testing at Manufacturer's works, proper packing and delivery to site of **ACSR (MOOSE, BERSIMIS, ZEBRA) & AAC (BULL) CONDUCTOR** conforming to this specification.

2.2 It is not the intent to specify herein all the details of design & manufacture of material. However, the material shall conform in all respect to high standard of design, engineering & workmanship and shall be capable of performing in continuous commercial operation at site condition.

2.3 Technical requirements of **ACSR (MOOSE, BERSIMIS, ZEBRA) & AAC (BULL) CONDUCTOR** are indicated in Technical Data Section-I & Section-II.

2.4 The stipulation(s) of Section-I shall prevail in case of any conflict between the stipulations of Section-I & Section-II, however, bidder shall furnish list of conflict (s)/ ambiguity(ies)/ deviation(s), if any, along with their technical offer and also furnish the basis(s)/ reason(s)/ justification(s) that is considered for submitting technical offer. BHEL/Owner will resolve listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL/Owner of their interpretation. In case bidder fails to convey the same prior to award, decision of BHEL/Owner decision on interpretation shall be considered final and binding if need arises during the execution. No additional commercial implication on account of conflict(s)/ ambiguity(ies)/ deviation(s) shall be admissible.

## 3.0 BILL OF QUANTITIES

3.1 The bidder shall quote for items as per **BOQ/ PRICE SCHEDULE** attached with Notice Inviting Tender (NIT). **The quantity as mentioned in the BOQ is only for evaluation purpose.** However actual ordered quantity may vary from project to project throughout the contract.

3.2 The **BOQ/ PRICE SCHEDULE** is as per **ANNEXURE-BOQ.**

## 4.0 DRAWINGS & DOCUMENTS TO BE SUBMITTED

4.1 After finalization of rate contract; against specific project requirement following information shall be provided by BHEL,

1. BOQ of required conductor type
2. Project site information

4.2 Following documents shall be submitted for specific project requirement after placement of order for the approval of BHEL/Customer,

| Sl. no. | Drawing / Document Description | Document no. | Document Type | First Submission | Resubmission |
|---|---|---|---|---|---|
| 1 | Conductor Cross Section with Technical Data Sheet | TB-XXX-316-E111 | Primary | Within 2 week of PO | Within 1 week of comments |
| 2 | Drum Drawing | TB-XXX-316-E112 | Primary | Within 2 week of PO | Within 1 week of comments |
| 3 | Type Test Reports | TB-XXX-316-E113 | Primary | Within 2 week of PO | Within 1 week of comments |

| | | | | | |
|---|---|---|---|---|---|
| 4 | Quality Plan | TB-XXX-316-E114 | Primary | Within 2 week of PO | Within 1 week of comments |
| 5 | Routine & Acceptance Test Reports | TB-XXX-316-E115 | Secondary | Within 1 week of ~~PO~~ Inspection | |

**Notes**

1. Approval on Primary documents is essential for providing manufacturing clearance.
2. The bidder/ manufacturer may note that all re-submissions must incorporate all comments given in the prior submission by the Purchaser. Adequate justification for not incorporating the same must be submitted, failing which the submitted documents may be returned.

4.3 Drawings/ Documents – Distribution of copies

| Sl. no. | Stages | Set of copies | Submission schedule |
|---|---|---|---|
| 1 | First submission | 6 | Within 2 weeks of award of contract |
| 2 | Re-submission, if required | 6 | Within 1 week of comments |
| 3 | Distribution copies of drawings in bound volume | 6 | Within ½ weeks of final approval |
| 4 | Distribution copies of type test reports drawings in bound volume | 6 | Within ½ weeks of final approval |
| 5 | Distribution copies of routine test reports in bound volume | 6 | Within ½ weeks of final approval |
| 6 | Compact disc/ Pen drive | 1 | Within ½ weeks of final approval |

## 5.0 TECHNICAL QUALIFYING REQUIREMENT & EXPERIENCE

The technical qualifying requirement & experience shall be as per attached **Annexure-TQR.**

## 6.0 TYPE TESTING

6.1 The bidder shall submit the type tests reports for the tests conducted on the conductor(s) identical or similar to those to be supplied under this contract and the test(s) should have been conducted at CPRI/ any NABL accredited independent laboratory/ any accredited laboratory (Accredited based on ISO/ IEC Guide 25/ 17025 or EN 45001 by the national accreditation body of the country, where the laboratory is located) not earlier than five (5) years from the date of original scheduled date of bid opening.

6.2 In case, any type test report is found to be technically unacceptable due to project/ customer specific testing procedure other than that mentioned in section-II, such type test(s) shall be conducted by the bidder without any commercial implication to BHEL.

6.2 Type test reports of the conductor shall be submitted for approval of BHEL/customer, as per following details but not limited to this,

1. UTS test on stranded conductor
2. Corona extinction voltage test (dry)
3. Radio interference voltage (RIV) test (dry), and
4. DC resistance test on stranded conductor

## 7.0 QUALITY ASSURANCE, TESTING & INSPECTION

7.1 At contract stage, the successful bidder shall submit the same Quality Plan (QP) for approval of BHEL/ customer at contract stage. In case bidder has reference Quality Plan agreed with customer, same can be submitted for specific project after award of contract for approval/ extension BHEL/customer. There shall not be any commercial implication to BHEL on account of changes in Quality Plan (QP) during contract stage.

7.2 All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved Quality Plan (QP). The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification.

7.3 The supplier shall perform all routine and acceptance tests during manufacturing as per requirement of the specification. The material shall be offered for inspection by BHEL/customer in accordance with agreed Quality Plan (QP) with 1 Week advance information. Commercial implications, if any for all these tests shall be deemed to be included in the bid price.

7.4 The contractor shall offer material for sample selection for type testing, only after approval of Quality Plan.

## 8.0 PACKING AND MARKING

8.1 The conductor shall be wound on non-returnable drums conforming to IS:1778 strong enough and provided with lagging of adequate strength, constructed to protect the conductor against all damages and displacements during transit, storage and subsequent handling and straining operations in the field. Only one conductor length shall be packed on each drum.

8.2 Each drum shall have following information marked on it along with other essential data:

1. Name of manufacturer
2. Drum no.
3. Size and length of conductor
4. Net weight of conductor
5. Total weight
6. Arrow marking for unwinding, and
7. Position of the conductor end

## 9.0 ABBREVIATIONS USED

NIT: Notice Inviting Tender
QP: Quality Plan
BOQ: Bill of Quantities
ACSR: Aluminium Conductor Steel Reinforced
AAC: All Aluminium Conductor
PO: Purchase Order
UTS: Ultimate Tensile Strength
RIV: Radio Interference Voltage
ACSR: Aluminium Conductor Steel Reinforced
AAC: All Aluminium Conductor
NABL: National Accreditation Board for Testing and Calibration Laboratories
IEC: International Electro-Technical Commission
ISO: International Organization for Standardization
IS: Indian Standard
EN: European Standard

# SECTION - II

# STANDARD TECHNICAL REQUIREMENTS

## 1.0 CODES AND STANDARDS

1.1 The materials for conductor shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where it is to be installed.

1.2 The ACSR Conductor shall conform to IEC:1089/ IS:398 (Part V)/ any other applicable standard, if it ensures equivalent or superior performance.

1.3 The AAC Conductor shall conform to IEC:1089/ IS:398 (Part V)/ any other applicable standard, if it ensures equivalent or superior performance.

1.4 The design, material, construction, manufacture, inspection and testing of ACSR (moose, Bersimis, Zebra) & AAC (Bull) conductor shall conform to the latest revision of relevant standards.

1.5 In case of conflict between the applicable reference standard and this specification, this specification shall govern.

1.6 The conductor shall strictly conform to the following but not limited to Indian and International standards, as appropriate but not limited to,

1. IS 398 (Part-I) Aluminium conductors for overhead transmission purposes
2. IEC 1089/IS 398 (Part-V) Aluminium conductors galvanized steel reinforced
3. IS 2629: 1990 Recommended practice for hot dip galvanizing on iron and steel.
4. IS 4826: 1992 Hot dip galvanized coatings on round steel wires
5. IS 2633: 1992 Method for testing uniformity of coating of zinc--coated articles.
6. IS 6745: 1990 Methods for determination of mass of zinc coating on zinc coated iron and steel articles
7. IS 8263: 1990 Methods for radio interference test
8. IS 1778: 1980 Reels and drums for bare conductors
9. IS 1521: 1991 Method for tensile testing of steel wire
10. IEC 888 Zinc coated steel wire for stranded conductors
11. IEC 889 Hard drawn aluminium wire for overhead line conductors
12. IS 209 Zinc ingot specification
13. IEC 437 Radio inference test on high voltage insulator
14. IEC 1089 Radio wire concentric lay overhead electrical standard conductors

## 2.0 TECHNICAL REQUIREMENT

### 2.1 Workmanship

2.1.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/ hand pressure and/ or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

2.1.2 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing.

2.1.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the Technical Data Sheet-A. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC 888.

2.1.4 The steel strands shall be pre-formed and post-formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid damage to galvanization during pre-forming and post-forming operation.

### 2.2 Joints in wires

#### 2.2.1 Aluminium wires

During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

No joints shall be permitted in the individual wires in the outermost layer of the finished conductor. However, joints are permitted in the inner layers of the conductor unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

2.2.2 Steel wires

There shall be no joint of any kind in the finished wire used for manufacturing of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

2.3 Tolerances

The manufacturing tolerances to the extent indicated in Technical Data Sheet-A shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

2.4 Materials

2.4.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC 889.

2.4.2 Steel

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the Technical Data Sheet-A. The steel wire drums shall have the same properties and characteristics as prescribed for regular strength wire in IEC: 888.

2.4.3 Zinc

The zinc used for galvanizing shall be electrolytic high grade zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS 209: 1979.

2.5 Standard length

The conductor shall be supplied as required. No joint shall be allowed within a single span of stringing, jumpers and equipment interconnection.

2.6 Tests

The conductor should have been type tested as per IEC/IS. Following Acceptance & Routine tests and tests during Manufacturing shall be carried out on the conductor. The sample shall be manufactured strictly in accordance with the quality assurance plan approved by owner.

2.6.1 Type Tests

The type test, acceptance & routine test and test during manufacturing shall be as following details but not limited to,

2.6.1.1 The conductor should have been type tested as per IEC/IS. In accordance with the stipulation of the specification, the following type test/ type test reports of the conductor shall be conducted/submitted for approval/ extension,

1. UTS test on stranded conductor (as per Annexure-C)
2. Corona extinction voltage test (dry) (as per Annexure-C)
3. Radio interference voltage test (dry) (as per Annexure-C)
4. DC resistance test on stranded conductor (as per Annexure-C)

2.6.2 Acceptance Tests

1. Visual check for joints, scratches etc. and length of conductor (as per Annexure-C)
2. Dimensional check on steel and aluminium strands (as per Annexure-C)

3. Check for lay-ratios of various layers (as per Annexure-C)
4. Galvanizing test on steel strands (as per Annexure-C)
5. Torsion and Elongation test on steel strands (as per Annexure-C)
6. Breaking load test on steel and aluminium strands (as per IEC 888, IEC 889)
7. Wrap test on steel and aluminium strands (as per IEC 888, IEC 889)
8. DC resistance test on aluminium strands (as per IEC 889)
9. UTS test on welded joint of aluminium strands (as per Annexure-C)

Note: All the above tests except test mentioned at Sl.No.1 shall be carried out on aluminium and steel strands after stranding only.

2.6.3 Routine Tests

1. Check to ensure that the joints are as per specification.
2. Check that there are no cuts, fins etc. on the strands
3. All acceptance test as mentioned above to be carried out on each coil/drum, as applicable.

2.6.4 Tests during Manufacture

1. Chemical analysis of zinc used for galvanizing (as per Annexure C)
2. Chemical analysis of aluminium used for making aluminium strands (as per Annexure C)
3. Chemical analysis of steel used for making steel strands (as per Annexure C)

## ANNEXURE-C
## TESTING PROCEDURE FOR ACSR/ AAC CONDUCTOR

### 1.0 TYPE TESTS

#### 1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at a steady rate to 100% of minimum specified UTS and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

#### 1.2 Corona Extinction Voltage Test

Two samples of conductor of 5m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per **Annexure-D1/ D2,** as applicable; in line with **Technical Data Sheet - A**.

#### 1.3 Radio Interference Voltage Test

Under the conditions as specified under Sl. No. 1.2 above, the conductor sample shall have radio interference voltage as indicated in **Technical Data Sheet - A**. This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC 437.

#### 1.4 D.C Resistance Test on Stranded Conductor

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at $20^0$C as per clause no. 12.8 of IS 398 (Part V): 1982.The resistance corrected at $20^0$C shall conform to the requirements of this specification.

### 2.0 ACCEPTANCE TESTS

#### 2.1 Visual Check for Joints, Scratches etc. for complete length of conductor

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conforms to the requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

#### 2.2 Dimensional Check on Steel and Aluminium Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

#### 2.3 Check for Lay –ratios of various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification and clause no. 9.4 and 9.5 of IS 398 (Part-V)-1982.

#### 2.4 Galvanising Test on Steel wire

The test procedure shall be as specified in IEC 888/ IS 4826: 1968. The material shall conform to the requirements of this specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

#### 2.5 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause no. 10.3 of IEC 888/ IS 398 (Part V): 1982. In torsion test, the number of complete twists before fracture shall not be less than that indicated in Technical Data Sheet-A. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it

will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

2.6 UTS test on welded Aluminium strands

Two Aluminium wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

**Note:** All the above tests except test mentioned at Sl. No. 2.1 shall be carried out on aluminium and steel strands after stranding only.

## 3.0 ROUTINE TESTS

3.1 Check to ensure that the joints are as per specification

3.2 Check that there are no cuts, fins etc. on strands.

3.3 All acceptance tests as mentioned above to be carried out on each coil/ drum, as applicable.

## 4.0 TESTS DURING MANUFACTURE

4.1 Chemical Analysis of zinc used for galvanising

Samples taken from the zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

4.2 Chemical Analysis of Aluminium used for making aluminium strands

Samples taken from the Aluminium ingots/ coils/ strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements in this specification.

4.3 Chemical Analysis of Steel used for making steel strands

Samples taken from the Steel ingots/ coils/ strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements in this specification.

## ANNEXURE-D1
## CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

2. Test Levels

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV

3.1 RIV tests shall be made according to measuring circuit as per International Special- Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100% and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400kV, 220kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona [applicable for 400kV and above]

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed

such that test object essentially, fills the frame with no cut-off. In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

4 1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4 2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

4 3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4 4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report,

1. Background noise before and after test.
2. Detailed procedure of application of test voltage.
3. Measurements of RIV levels expressed in micro volts at each level.
4. Results and observations with regard to location and type of interference sources detected at each step.
5. Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
6. Onset and extinction of visual corona for each of the four tests required shall be recorded.

## ANNEXURE-D2
## CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

### 1. General

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

### 2. Test Levels

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

### 3. Test Methods for RIV

3.1 RIV tests shall be made according to measuring circuit as per International Special- Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400kV, 220kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

### 4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130%, the voltage shall be raised further till inception of corona or 420Kv, whichever is minimum. Thereafter the voltage will be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears.

4.1 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.2 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

## TECHNICAL DATA SHEET-A

### 1. Conductor type: ACSR (Moose/ Bersimis/ Zebra) Conductor

| Sl. No. | Description | ACSR Moose | ACSR Bersimis | ACSR Zebra |
|---|---|---|---|---|
| 1.0 | **Applicable Standard** | IS 398/ IEC 1089 | IS 398/ IEC 1089 | IS 398/ IEC 1089 |
| 2.0 | **Raw Materials** | | | |
| 2.1 | Aluminium | | | |
| a) | Minimum purity of Aluminium | 99.50% | 99.50% | 99.50% |
| b) | Maximum copper content | 0.04% | 0.04% | 0.04% |
| 2.2 | Steel wires/ rods | | | |
| a) | Carbon | 0.50% to 0.85% | 0.50% to 0.85% | 0.50% to 0.85% |
| b) | Manganese | 0.50% to 1.10% | 0.50% to 1.10% | 0.50% to 1.10% |
| c) | Phosphorous | Not more than 0.035% | Not more than 0.035% | Not more than 0.035% |
| d) | Sulphur | Not more than 0.045% | Not more than 0.045% | Not more than 0.045% |
| e) | Silicon | 0.10% to 0.35% (Max.) | 0.10% to 0.35% (Max.) | 0.10% to 0.35% (Max.) |
| 2.3 | Zinc | | | |
| a) | Minimum purity of Zinc | 99.95% | 99.95% | 99.95% |
| 3.0 | **Aluminium strands after stranding** | | | |
| 3.1 | Diameter | | | |
| a) | Nominal | 3.53 mm | 4.57 mm | 3.18 mm |
| b) | Maximum | 3.55 mm | 4.61 mm | 3.21 mm |
| c) | Minimum | 3.51 mm | 4.53 mm | 3.15 mm |
| 3.2 | Minimum breaking load of strand | | | |
| a) | Before stranding | 1.57 kN | 2.64 kN | 1.29 kN |
| b) | After stranding | 1.49 kN | 2.51 kN | 1.23 kN |
| c) | Maximum DC resistance of strand at 20 deg. C | 2.921 Ohm/km | 1.738 Ohm/km | 3.626 Ohm/km |
| 3.3 | Maximum resistance of 1 m length of strand at 20 deg. C | 0.002921 Ohm | 0.001738 Ohm | 0.003626 Ohm |
| 4.0 | **Steel strand after stranding** | | | |
| 4.1 | Diameter | | | |
| a) | Nominal | 3.53 mm | 2.54 mm | 3.18 mm |
| b) | Maximum | 3.60 mm | 2.57 mm | 3.24 mm |
| c) | minimum | 3.46 mm | 2.51 mm | 3.12 mm |
| 4.2 | Minimum breaking load of strand | | | |
| a) | Before stranding | 12.86 kN | 6.87 kN | 10.43 kN |
| b) | After stranding | 12.22 kN | 6.53 kN | 9.91 kN |
| 4.3 | Galvanising | | | |
| a) | Minimum weight of zinc coating per sq.m. | 260 gm | 260 gm | 260 gm |
| b) | Minimum number of dips that the | 2 dips of one minute & 1dip of half minute | 2 dips of one minute & 1dip of half minute | 2 dips of one minute & 1dip of half minute |

| | | | | |
|---|---|---|---|---|
| | galvanised strand can withstand in the standard preece test | | | |
| c) | Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding) | 16 (After stranding)<br>18 (Before stranding) | 16 (After stranding)<br>18 (Before stranding) | 16 (After stranding)<br>18 (Before stranding) |
| **5.0** | **ACSR Conductor** | | | |
| 5.1 | Stranding | | | |
| a) | Stranding details | Al -54/3.53 mm+ Steel-7/3.53 mm | Al -42/4.57 mm+ Steel-7/2.54 mm | Al -54/3.18 mm+ Steel-7/3.18 mm |
| b) | Number of strands | | | |
| i) | Steel centre | 1 Nos. | 1 Nos. | 1 Nos. |
| ii) | 1st Steel Layer | 6 Nos. | 6 Nos. | 6 Nos. |
| iii) | 1st Aluminium Layer | 12 Nos. | 8 Nos. | 12 Nos. |
| iv) | 2nd Aluminium Layer | 18 Nos. | 14 Nos. | 18 Nos. |
| v) | 3rd Aluminium Layer | 24 Nos. | 20 Nos. | 24 Nos. |
| 5.2 | Sectional Area of aluminium | 528.50 sq.mm | 689.50 sq.mm | 428.9 sq.mm |
| 5.3 | Total sectional area | 597.00 sq.mm | 725.00 sq.mm | 484.5 sq.mm |
| 5.4 | Approximate Weight | 2.004 kg/m | 2.181 kg/m | 1.621 kg/m |
| 5.5 | Diameter of the conductor | 31.77 mm | 35.05 mm | 28.62 mm |
| 5.6 | UTS of the conductor | 161.20 kN (Min) | 154 kN (Min) | 130.32 kN (Min) |
| 5.7 | Lay ratio of the conductor | Max Min | Max Min | Max Min |
| a) | Outer Steel layer | 18 16 | 24 16 | 28 13 |
| b) | 8/12 wire Aluminium layer | 14 12 | 17 10 | 17 10 |
| c) | 14/ 18 wire Aluminium layer | 13 11 | 16 10 | 16 10 |
| d) | 20/24 wire Aluminium layer | 12 10 | 13 10 | 14 10 |
| 5.8 | DC resistance of the conductor at 20°C | 0.05552 Ohm/km | 0.04242 Ohm/km | 0.06868 Ohm/km |
| 5.9 | Standard length of the conductor | 1800 m | 1800 m | 1800 m |
| 5.10 | Tolerance on Standard length | (±)5% | (±)5% | (±)5% |
| 5.11 | Direction of lay of outer layer | Right Hand | Right Hand | Right Hand |
| 5.12 | Linear mass of the conductor | | | |
| a) | Standard | 2004 kg/km | 2181 kg/km | 1621 kg/km |
| b) | Minimum | 1965 kg/km | 2142 kg/km | 1589 kg/km |

| | | | | |
|---|---|---|---|---|
| c) | Maximum | 2045 kg/km | 2221 kg/km | 1653 kg/km |
| 5.13 | Modulus of Elasticity (Final State) | 6860 kg/sq.mm | -- | -- |
| 5.14 | Co-efficient of Linear Expansion | $19.3 \times 10^{-6}$ per deg. C | $21.5 \times 10^{-6}$ per deg. C | $19.3 \times 10^{-6}$ per deg. C |
| 5.15 | Minimum Corona Extinction Voltage | 320 kV rms | 320 kV rms | 154 kV rms |
| 5.16 | RIV at 1 Mhz under dry condition | Max. 1000 microvolts at 320 kV rms | Max. 1000 microvolts at 320 kV rms | Max. 1000 microvolts at 154 kV rms |
| **6.0** | **Drum Dimensions** | | | |
| 6.1 | Applicable Standard | Generally confirms to IS: 1778 | Generally confirms to IS: 1778 | Generally confirms to IS: 1778 |
| 6.2 | Drum Dimensions | | | |
| a) | Flange Diameter | 1800 mm | 1800 mm | 1850 |
| b) | Traverse width | 950 mm | 950 mm | 925 |
| c) | Barrel Diameter | 650 mm | 650 mm | 650 |
| d) | Flange thickness | 50x50 mm | 50x50 mm | 50x50 |

## TECHNICAL DATA SHEET-A
## 2. Conductor type: AAC (Bull) Conductor

| Sl. No. | Description | AAC Bull | | |
|---|---|---|---|---|
| **1.0** | **Applicable Standard** | IS: 398 | | |
| **2.0** | **Raw Materials** | | | |
| 2.1. | Aluminium | | | |
| a) | Minimum purity of Aluminium | 99.50% | | |
| b) | Maximum copper content | 0.04% | | |
| **3.0** | **Aluminium strands after stranding** | | | |
| 3.1 | Diameter | | | |
| a) | Nominal | 4.25 mm | | |
| b) | Maximum | 4.29 mm | | |
| c) | Minimum | 4.21 mm | | |
| 3.2 | Minimum breaking load of strand | | | |
| a) | Before stranding | 2.23 kN | | |
| b) | After stranding | 2.12 kN | | |
| c) | Maximum D.C. resistance of strand at 20 deg. Centigrade | 2.03 Ohm/km | | |
| 3.3 | Maximum resistance of 1 m length of strand at 20 deg. C | 0.00203 Ohm | | |
| **4.0** | **AAC Conductor** | | | |
| 4.1 | Stranding | | | |
| a) | Stranding details | Al -61/4.25 mm | | |
| b) | Number of strands | | | |
| i) | 1st Aluminium Layer | 1 Nos. | | |
| ii) | 2nd Aluminium Layer | 6 Nos. | | |
| iii) | 3rd Aluminium Layer | 12 Nos. | | |
| iv) | 4th Aluminium Layer | 18 Nos. | | |
| v) | 5th Aluminium Layer | 24 Nos. | | |
| 4.2 | Sectional Area of aluminium | 865.36 sq.mm | | |
| 4.3 | Total sectional area | 865.36 sq.mm | | |
| 4.4 | Approximate Weight | 2.4 kg/m | | |
| 4.5 | Diameter of the conductor | 38.25 mm | | |
| 4.6 | UTS of the conductor | 139 kN (min.) | | |
| 4.7 | Lay ratio of the conductor | Max Min | | |
| a) | 6 wire Aluminium layer | 16 10 | | |
| b) | 12 wire Aluminium layer | 16 10 | | |

| | | | | |
|---|---|---|---|---|
| c) | 18 wire Aluminium layer | 16 10 | | |
| d) | 24 wire Aluminium layer | 14 10 | | |
| 4.8 | DC resistance of the conductor at 20°C | 0.03340 Ohm/km | | |
| 4.9 | Standard length of the conductor | 1000 m | | |
| 4.10 | Tolerance on Standard length | (±)5% | | |
| 4.11 | Direction of lay of outer layer | Right Hand | | |
| 4.12 | Linear mass of the conductor | | | |
| a) | Standard | 2400 kg/km | | |
| b) | Minimum | 2355 kg/km | | |
| c) | Maximum | 2445 kg/km | | |
| 4.13 | Modulus of Elasticity | 4709 kg/sq.mm (Initial)<br>5869 kg/sq.mm (Final) | | |
| 4.14 | Co-efficient of Linear Expansion | $23.0 \times 10^{-6}$ per deg. C | | |
| 4.15 | Minimum Corona Extinction Voltage | 508 kVrms | | |
| 4.16 | RIV at 1 Mhz | Less than 1000 microvolts at 508 kVrms | | |
| **5.0** | **Drum Dimensions** | | | |
| 6.1 | Applicable Standard | Generally confirms to IS 1778 | | |
| 6.2 | Drum Dimensions | | | |
| a) | Flange Diameter | 1855 mm | | |
| b) | Traverse width | 925 mm | | |
| c) | Barrel Diameter | 850 mm | | |
| d) | Flange thickness | 50x50 mm | | |

# SECTION- 3

## PROJECT DETAILS AND GENERAL SPECIFICATIONS

### 3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

### 3.1 PROJECT DETAILS

| | **Particular** | **Details** |
|---|---|---|
| **a)** | Customer | NTPC Ltd. |
| **b)** | Engineer/Consultant/ Inspector | NTPC Ltd. |
| **c)** | Project Title | North Karanpura Super Thermal Power Project (3x660 MW) : 400/220kV Switchyard at NKSTPP end & 220kV Sub-station at Mine end |
| **d)** | Project Location | Place: Near Tandwa town<br>District: Hazaribagh & Chatra<br>State: Jharkhand |
| **e)** | Latitude & Longitude | **400/220kV S/s at NKSTPP:**<br>North: 23°50' to 23°52' and East: 84°59' to 85°2'<br><br>**220kV S/s at Chatti Bariatu & Kerandari-A mine:**<br>North: 23°52'35" and East: 85°05'25" |
| **f)** | Nearest Railway Station | Khalari Railway Station Ranchi-Garhwa section of Eastern Railways |
| **g)** | Distance of project location from the Railway station | 40 Km (approx.) |
| **h)** | Nearest Major Town | Hazaribagh city |
| **i)** | Distance of the town from the project site | 50 Km. |
| **j)** | Nearest commercial airport | Ranchi |
| **k)** | Distance of airport from the project site | 150 Km |
| | **SITE CONDITIONS** (for design purposes) | |
| **a)** | Design ambient temperature | 50°C |
| **b)** | Maximum Relative humidity | 95 % |
| **c)** | Height above mean sea level | Less than 1000 meters |
| **d)** | Pollution Severity | Heavily polluted (With Coal dust & Fly ash) and Highly Corrosive environment. |
| **e)** | Criteria for Wind Resistant design of structures and equipment | Standard Applicable - IS 875 (Part 3) 1987 |
| **f)** | Basic Wind speed "Vb" at ten meters | 39 m/ sec |

| | | |
|---|---|---|
| | above the mean ground level. | |
| **g)** | Category of terrain | Cat –2 |
| **h)** | Risk Coefficient "K1" | 1.06 |

3.1.1 **SYSTEM PARAMETERS:**

| Sl.No. | Parameters | 400 kV | 220 kV |
|---|---|---|---|
| 1 | Highest system voltage | 420 kV rms | 245 kVrms |
| 2 | Lightning Impulse voltage | ±1425kVp | ± 1050kVp |
| 3 | Switching impulse voltage | ±1050kVp | - |
| 4 | Power frequency withstand for 1 min (rms) | 630 kV(rms) | 460 kV(rms) |
| 5 | Max. fault level (1 sec.) | 50 kA | 40kA |
| 6 | Minimum creepage distance | 10500 mm | 6125mm |

3.1.2 **AUXILIARY POWER:**

| Sl.No. | Nominal Connection Voltage | Variations in Voltage | Frequency | Phase | Neutral |
|---|---|---|---|---|---|
| 1 | 415V | ±10% | 50 (+3% -5%) | 3Phase , 4 Wire | Solidly Earthed |
| 2 | 240V | ±10% | 50 (+3% -5%) | 1 phase | Solidly Earthed |

Combined variation of voltage and frequency shall be + 10%. Design fault level of 415V system shall be restricted to 50kA rms for 1 second.

The operational limits for variation of DC voltage are (+) 10% to (-) 15%.

**3.1.3** The various minimum heights of the switchyard shall be as given below from plinth level:

| Voltage | Equipment /1st Level | 2nd Level | 3rd Level | Peak |
|---|---|---|---|---|
| 220kV | 6000mm | 12000mm | 17000mm | 8500mm |
| 400kV | 8000mm | 16000mm | 23000mm | 8500mm |

The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or support insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550mm.

The minimum height of intermediate gantry tower for 400kV wherever required shall be 25 m and the peak (s) shall be of 8.5 m.

**3.1.4** The minimum clearances for 400kV & 220 kV switchyards shall be as given below:

| | **400kV** | **220kV** |
|---|---|---|
| Phase to earth clearance | 3500 mm | 2100mm |
| Phase to phase clearance | 4000 mm | 2100mm |
| Section clearance | 6500 mm | 5000mm |

**3.2 INSTRUCTION TO BIDDERS:**

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

It is recognized that the bidders may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar

equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Except for lighting fixtures, wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition. For lighting fixtures, makes shall be as defined in Section-Lighting System.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

## 3.3 CODES AND STANDARDS

The supplier is required to follow local statutory regulations stipulated in the latest amended Electricity Supply Act 1948 and Indian Electricity Rules 1956 (latest), and other local rules and regulations.

The equipment to be furnished under this specification shall conform to latest issue with all amendments of standards and/ or codes specified under respective section heads. The standards mentioned in the specification are not mutually exclusive or complete in them, but intended to complement each other. The supplier shall also note that list of standards presented in this specification is not complete. Whenever necessary the list standards shall be considered in conjunction with specific IS/IEC. When the specified requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards which ensure equivalent or better performance that specified in the standards referred under section shall also be acceptable.

In case governing standards for the equivalent for the equipment is different from IS/ IEC, the salient points of difference shall be clearly brought out in additional information schedule along with English language version of standard of relevant extract of the same. The equipment conforming to standards other than IS/ IEC shall be subject to Purchaser’s approval.

The full names of the codes and standards mentioned in abbreviations under various equipment heads are as follows:

| | |
|---|---|
| BS | British Standards |
| IEC/ CISPR | International Electro-technical Commission |

| | |
|---|---|
| IS | Bureau of Indian Standards |
| ISO | International Organization for Standards |
| NEMA | National Electric Manufacturers Association |

### 3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions. All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (not applicable for this project) short circuit etc for the equipment .

The equipment shall also comply with the following:

a) All equipments shall be suitable for hot line washing.
b) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
c) Piping, if any, between equipment control cabinet or operating mechanism to marshalling box of the equipment shall bear proper identification to facilitate the connection at site.
d) All equipment shall be supplied with necessary inter-pole cabling, and its cost shall be included in the cost of equipment.

### 3.5 ENGINEERING DATA

#### 3.5.1 Drawings

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

After the approval of the drawings, further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these data by the purchaser will cover only general conformance of the data to the specification and documents, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect plan layout. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the purchaser shall not be considered by the contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

All engineering data submitted by the contractor after final process including review and approval by the purchaser shall form part of the contract document and the entire work performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the purchaser in writing.

### 3.5.2 Approval Procedure

The following procedure for submission and review/approval of the drawings, data,reports, information, etc. shall be followed by Contractor:

a. All data/information furnished by Vendor in the form of drawings, documents, Catalogues or in any other form for NTPC's information/interface and/or review and approval are referred by the general term "drawings".

b. The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

c. All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.

d. Contractor shall submit all the drawings in five (5) copies for review of Employer. Employer shall forward their comments within four (4) weeks of receipt of drawings.

e. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

| | |
|---|---|
| CATEGORY I | Approved |
| CATEGORY II | Approved subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments |
| CATEGORY III | Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted |
| CATEGORY IV | For information and records |

f. Contractor shall resubmit the drawings approved under Category II, III within one (1) week of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.).

g. In case Contractor does not agree with any specific comment, he shall furnish the explanation for the same to Employer consideration. In all such cases Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

h. It is the responsibility of the Contractor to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay

arising out of submission and modification of drawings shall not alter the contract completion schedule.

i. Contractor shall not make any changes in the portion of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawings identifying the changes (along with reasons for changes) for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

j. Approval of drawings will not in any way relieve the Contractor of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

**3.5.3 Erection Drawings.**

a. Contractor shall furnish erection drawings for the guidance or commencement of erection or the first shipment, whichever is earlier. These shall generally comprise of fabrication/assembly drawings, various component/part details drawing, assembly, clearance data requirements, etc. The drawings shall contain details of components/ equipment with identification number, match marks, bill of materials, assembly procedures etc.

b. For all major equipment apart from above details, assembly sequence and instructions with check-lists shall be furnished in the form of erection manuals.

**3.5.4 Instruction Manual**

a. The Contractor shall submit to the Employer preliminary instruction manuals for all the equipments for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least sixty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipments, the transportation, storage, installation, testing, operation and maintenance procedures, etc. separately for each component/equipment along with log record format. These instruction manuals shall be submitted in five (5) copies for approval.

b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall being corporate and the updated final instruction manuals shall be submitted.

c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.

d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together will all relevant pamphlets.

e. The manuals shall include the following

a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.

b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

f. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.

g. A collection of the manufacturer's standard leaflets will not accepted to be taken as a compliance of this clause. The manual shall be specifically compiled for the concerned project.

**3.5.5 Final Submission of drawings and documents:**

The Contractor shall furnish the following after approval of all drawings /documents and test reports:

a. List of drawings bearing the Employer's and Contractor's drawing number.
b. Two (2) bound sets alongwith 4 CD-ROMs of all drawing.
c. All documents/designs in two (2) copies as noted above.
d. Contractor shall also furnish six (6) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Contractor shall also furnish two (2) sets of CD-ROMs/ DVD/Portable hard disk of all as-built drawings as decided by the Employer.
e. The Contractor shall also furnish four (4) copies of instruction/ operations & maintenance manuals (after approval) for all the equipments.

**3.5.6 TEST REPORTS**

Two (2) copies of all test reports shall be supplied for approval before shipment of Equipment. The report shall indicate clearly the standard value specified for each test to facilitate checking of the reports. After final approval six (6) bound copies of all type and routine test reports shall be submitted to Employer.

**3.6 MATERIAL /WORKMANSHIP**

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

### 3.7 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

**SPACE HEATERS**

The heaters shall be suitable for continuous operation at 230 V as supply voltage. On –off switch and fuse shall be provided.

One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and the air and shall consist of coiled resistance wire centered in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air. Alternatively, they shall consist of a resistance wire mounted into a tubular ceramic body built into an envelope of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

**FUNGI STATIC VARNISH**

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

**Ventilation opening**

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

**Degree of Protection**

The enclosure of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a. Installed outdoor: IP- 55
b. Installed indoor in air conditioned area: IP-31
c. Installed in covered area: IP-52
d. Installed indoor in non air-conditioned area where possibility of entry of water is limited: IP-41.
e. For LT Switchgear (AC & DC distribution Boards) : IP-52

The degree of protection shall be in accordance with IS: 13947 (Part –I) / IEC-947 (Part-I) / IS 12063/IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

**PRESERVATIVE SHOP COATING**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification.

Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.

Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.

### 3.8 RATING PLATES, NAME PLATES AND LABELS

3.8.1 Each equipment shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer’s name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.

3.8.2 Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.

3.8.3 The rated current, extended current rating and rated thermal current shall be clearly indicated in the name plate in case of current transformer.

3.8.4 Rated voltage, voltage factor and intermediate voltage shall be clearly indicated on the nameplate in case of capacitor voltage transformer.

3.8.5 Each switch shall a clear inscription identifying its function. Switches shall also have a clear inscription of each position indication.

3.8.6 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

3.8.7 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

### 3.9 GALVANISING:

3.9.1 The galvanised surface shall consist of a continuous film adhering to the steel. The finished surface shall be clean and smooth, and shall be free from defects like dissolved patches, base, spot, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects shall render the material liable to rejection.

3.9.2 All exposed ferrous parts shall be hot dip galvanised as per IS:2629 & IS:2633, Galvanising shall be uniform, smooth continuous and free from acid spots. Should the galvanising of the sample be found defective, the entire batch of steel shall have to be re-galvanised at Contractor's cost. The amount of zinc deposit shall be not less than 610 gms. per sq.m. of surface area and in addition, the thickness of zinc at any spot shall not be less than 85 microns. The Employer reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument acceptable to Employer and reject any component which shows thickness of zinc at any location less than 85 microns. The testing on the galvanised materials shall be carried out as per IS:2633.

3.9.3 The amount of zinc deposit over threaded portion of the bolts, nuts and screws shall not be less than 300 gms. per sq. meter of surface area. The amount of zinc deposit on washers shall not be less than 340 gms. per sq. meter of surface area. The threads having extra deposit of zinc shall be removed by die cutting after the completion of galvanising. The removal of extra zinc shall be carefully done so that threads shall have minimum deposits of zinc on them as specified.

**3.10 PAINTING**

Unless explicitly stated in relevant chapters of the specification, the painting of all electrical equipment shall be as follows:
Epoxy based with suitable additives. The thickness of finish coat shall be minimum 50 microns (minimum total DFT shall be 100 microns). However in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 50 microns shall be acceptable for finish coat. Paint shade shall be as per technical specification.

**3.11 QUALITY ASSURANCE PROGRAMME**

3.11.1 The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his subcontractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS- 14001.

A quality assurance programme of the contractor shall generally cover the following:

i. His organisation structure for the management and implementation of the proposed quality assurance programme
ii. Quality System Manual
iii. Design Control System
iv. Documentation Data Control System
v. Qualification data for Bidder's key Personnel.
vi. The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
vii. System for shop manufacturing and site erection controls including process, fabrication and assembly.
viii. Control of non-conforming items and system for corrective actions and resolution of deviations.
ix. Inspection and test procedure both for manufacture and field activities.
x. Control of calibration and testing of measuring testing equipments.
xi. System for Quality Audits.
xii. System for identification and appraisal of inspection status.
xiii. System for authorising release of manufactured product to the Employer.
xiv. System for handling storage and delivery.

xv. System for maintenance of records, and

xvi. Furnishing quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed as Annexure-I.

### 3.12 GENERAL REQUIREMENTS - QUALITY ASSURANCE

3.12.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.

3.12.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.

3.12.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control Organisation, during various stages of site activities starting from receipt of materials/equipment at site.

3.12.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.

3.12.5 These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

3.12.6 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of MDCC.

3.12.7 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

3.12.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.

3.12.9 All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.

3.12.10 All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.

3.12.11 Test results or qualification tests and specimen testing shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

3.12.12 For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipments/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.

3.12.13 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

3.12.14 No welding shall be carried out on cast iron components for repair.

3.12.15 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

3.12.16 All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 50mm shall be ultrasonically tested.

The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the subcontractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified subcontractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

3.12.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the subcontractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control

organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc.

3.12.18 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub vendor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

3.12.19 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractors and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipments conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

3.12.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

3.12.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

3.12.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

**3.12.23 Environmental Stress Screening**

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following.

**1.** The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

**Or**

In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

**Elevated Temperature Test Cycle**

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

**Burn In Test Cycle**

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

## 3.13 QUALITY ASSURANCE DOCUMENTS

The Contractor shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identified in respective quality plan with tick ( √ ) mark.

Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks.

3.13.1 Typical contents of Quality Assurance Document are as below:-

i) Quality Plan,
ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

iv) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
v) Heat Treatment Certificate/Record (Time- temperature Chart)
vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.
viii) Certificate of Conformance (COC) whoever applicable.
ix) MDCC

3.13.2 Similarly, the contractor shall be required to submit two hard copies and two sets on CD ROM of Quality Assurance Documents ( in line with above) pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

3.13.3 Before dispatch/ commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory. The Inspector shall stamp the quality document (or applicable section) for release.
ii) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing finalizing the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
i) If a decision is made for dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

### 3.14 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer after the delivery date for the corresponding equipment. One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site.
For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 1 month after the date of the last delivery similarly as stated above.

### 3.15 INSPECTION, TESTING & INSPECTION CERTIFICATE

3.15.1 The word ‘Inspector’ shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

3.15.2 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect

and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

3.15.3 The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

3.15.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

3.15.5 When the factory tests have been completed at the Contractor's or subcontractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

3.15.6 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

3.15.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

3.15.8 To facilitate advance planning of inspection in addition to giving inspection notice, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

3.15.9 All inspection, measuring and test equipments used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipments in the presence of Project Manager / Inspector.

### 3.16 PACKAGING & TRANSPORTATION

**Items shall be packed & dispatched separately to respective sites i.e. to 400/220kV S/s at NKSTPP end & to 220kV S/s at Chatti Bariatu & Kerandari-A mine end.**

3.16.1 Packing, Marking and shipping

The packing and shipping shall be carried out in accordance with the standard practice of Contractor and with the following additional requirements:

a) The equipment shall be prepared in such a manner as to protect the equipment from damage or deterioration during shipping or storage. The shipments can be exposed to heavy rains, hot sun, high humidity and sudden extreme changes of temperature. The equipment shall be packed and shipped so as to protect it from all such conditions and any other abnormal conditions, generally expected during shipping & storage.

b) The metallic containers, if any, shall be considered as the property of the Contractor and he will be allowed to remove them from site once the contents are unpacked, inspected, documented and placed in temporary storage or in final position.

c) The equipment shall be shipped in such a manner as to facilitate unloading, handling and storage enroute and at the site. The Contractor shall provide lifting lugs and special lifting devices for proper handling and erection.

d) The Contractor shall be liable for any damage or loss resulting due to careless, improper, poor or insufficient packing and handling.

e) Spare parts and spare equipment shall be packed separately in containers adequate for long term storage, plainly marked “Spare Parts Only”. They shall be crated individually or in kits to be used in one single renewal or overhaul operation. Other spare part kits shall not be disturbed when using one set or kit.

f) The Contractor shall at all times protect and preserve from damage, loss, corrosion and all other forms of damage, all parts of the works.

3.16.2 Transportation

a) The Contractor shall make a careful examination of access rail/roadways to the site in order to confirm the practical maximum transport weight and dimensions as well as a careful examination of the ports of disembarkation particularly with respect to the capacity of the cranes installed and access roads.

b) All instruments and computer/microprocessor based equipment imported into India from overseas for the purpose of this contract shall be air freighted to the nearest possible point and further by rail/road taking due precautions as per manufacturer’s recommendations. Employer shall have the right to decide the items that should be air freighted and Employer’s decision shall be binding on Contractor.

3.16.3 Insurance

a) The Contractor shall insure all shipments and works at his own expense for not less than the full replacement cost plus any additional cost for accelerated manufacturing of the replacement parts.

b) Loss or the damage to equipment during shipping or transportation to the site(s) or otherwise

shall not constitute groups for claims for extension in time or for extra payment.

### 3.17 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

3.17.1 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.

3.17.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

3.17.3 Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

3.17.4 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

3.17.5 They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

3.17.6 Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

3.17.7 Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.

### 3.18 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS

3.18.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS: / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.
Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

3.18.2 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.

3.18.3 Glazing of the porcelain shall be uniform brown in colour, free form blisters, burns and other similar defects.

3.18.4 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.

3.18.5 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

3.18.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

3.18.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.18.8 Insulator shall also meet requirement of IEC - 815 as applicable, having alternate long & short sheds.

**3.19 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT.**

3.19.1 All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC:439 as applicable.

3.19.2 **Mechanism Box/ Control Cabinet/ Kiosks:** A sheet steel (atleast 2.5 mm thick), dust and vermin proof M.Box/CCC/CMB shall be provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber.

Painting of boxes shall be as follows,

- External surface : Chemical resistant epoxy zinc phosphate primer, MIO (Micaceious iron oxide) as intermediate paint followed by polyurethane finish paint **(RAL 5012 Blue)**
- Internal surface : Chemical resistant epoxy zinc phosphate primer followed by chemical & heat resistant **epoxy enamel white paint**.

3.19.3 **Junction Boxes:** The junction boxes shall be made of minimum 2 mm thick sheet steel. Gland plates shall be removable type and made of 3 mm thick sheet steel. The boxes shall be provided with detachable cover or hinged door with captive screws. Top of the box shall be arranged to slope towards the rear of the box. The box shall be **hot dip galvanised** and shall be provided with suitable neoprene gaskets to achieve requisite degree of protection. Adequate spacing shall be provided to terminate the external cables. The boxes shall be suitable for mounting on various types of steel structures. The terminal blocks provided shall be of 650 V grade, rated for 10 A for control cables. Suitable numbering for terminal blocks shall be done. In case of junction box for power cable, the box shall be rated for maximum current carrying capacity. Terminal blocks shall be of one piece, Klippon RSF-1 or ELMEX CSLT-1 type with insulating barriers.

3.19.4 The cabinets/boxes/kiosks/panels shall be free standing or wall mounting or pedestal mounting type. They shall have hinged doors with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets.

3.19.5 The degree of protection of of all the outdoor boxes shall not be less than IP 55 as per IS 2147.

3.19.6 The cable entry shall be from bottom, for which removable gasketed cable gland plates shall be provided.

3.19.7 Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.

3.19.8 The size of enclosure and the layout of equipment inside shall provide generous clearances. Each cabinet/box/kiosk/panel shall be provided with a 15A, 240V ac, 2 pole, 3 pin industrial grade receptacle with switch. For incoming supply, MCB of suitable rating shall be provided. Illumination of each compartment shall be with door operated incandescent lamp. All control switches shall be of rotary switch type.

3.19.9 Each cabinet/box/kiosk/panel shall be provided with two earthing pads to receive 75mmx12mm GS flat. The connection shall be bolted type with two bolts per pad. The hinged door shall be connected to body using flexible wire. The cabinets/boxes/kiosks/panels shall also be provided with danger plate, and internal wiring diagram pasted on inside of the door. The front label shall be on a 3mm thick plastic plate with white letters engraved on black background

**3.20 TERMINAL BLOCKS**

3.20.1 They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4.

3.20.2 The terminal blocks shall be of 650 V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated.

3.20.3 They shall be of moulded, non-inflammable thermosetting plastic. The material shall not deteriorate with varied conditions of temperature and humidity. The terminal blocks shall be fully enclosed with removable covers of transparent, non deteriorating plastic material. Insulating barriers shall be provided between the terminal blocks so that the barriers do not hinder the wiring operation without removing the barriers.

3.20.4 The terminals shall be provided with marking tags for wiring identification.

3.20.5 Unless otherwise required (expected current rating) or specified, terminal blocks shall be suitable for connecting the following conductors on each side:
All CT & VT circuits - Min. four 2.5 sq.mm. copper flexible conductor
AC & DC power supply -Two 16 sq.mm. Aluminium conductor
Other control circuits - Min. two 2.5 sq.mm. copper flexible conductor.

3.20.6 The terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall also be provided with short circuiting and earthing facilities.

**3.21 Wiring**

3.21.1 All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:
a) All circuits except CT circuits 2.5 sq.mm
b) CT circuits 4 sq. mm (minimum number of strands shall be 3 per conductor).

3.21.2 All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

3.21.3 Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires

shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.

3.21.4 All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.

3.21.5 All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Interpole cabling for all equipment's shall be carried out by the Contractor.

**3.22 CABLE GLANDS AND LUGS**

3.22.1 Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.

3.22.2 The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination.

3.22.3 Cables lugs for power cables shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipmentsThe cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

**3.4 CONDUITS, PIPES AND ACCESSORIES**

3.4.1 The bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.

3.4.2 Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/ pipes shall be of a reputed make.

3.4.3 Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

**3.5 MOTOR CONTROL CENTRE**

3.5.1 The 415 Volt motor control centres (if provided separately) shall conform to the requirements for boxes/cabinets/kiosks. They shall be fixed type, shall be fully sectionalised and shall be equipped with load break switches. Motor feeders shall be provided with isolating switch fuse unit and Contractor with thermal overload relay and single phase protection. The motor Contractor shall have one normally open auxiliary contact for alarm purposes. The motor control circuit shall be independent from all other control circuits.

3.5.2 Isolating Switches

The incoming power supply isolating switch operation handle shall be interlocked with the control cabinet door as to prevent opening of door when main switch is closed. Device for by passing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

3.5.3 Fuses

All fuses shall be of the HRC cartridge type, conforming to IS: 2208 and suitable to mount on plug-in type of fuse bases. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded, and it shall be possible to change fuses with the circuit alive, without danger of contact with live conductor. Insulated fuse pulling handle shall be supplied with each control cabinet.

**3.6 MOTORS**

3.6.1 Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards.

3.6.2 Enclosures

a) For motors to be installed outdoor, the motor enclosure shall have degree of protection IP: 55. For motors to be installed indoor, i.e. inside a box, the motor enclosure shall be dust proof equivalent to IP: 54.
b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
c) Motors shall have drain plugs so located that they will drain water resulting condensation or other causes from all pockets in the motor casing.

3.6.3 Operational Features :

a) Continuous motor ratings (name plate rating) shall be at least suitable for the driven equipment at design duty operating point of driven equipment that will arise in service.
b) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the given system.

3.6.4 Starting Requirements

a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops.
b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
c) The locked rotor current shall not exceed six(6) times the rated full load current for all motors subject to tolerance given in IS:325.
d) Motors when started with driven equipment imposing full staring torque and supply voltage conditions specified shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by a least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Contractor shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower

than 20% and open for speeds above 20% of the rated. The speed switch shall be capable of withstanding 120% of the rated speed in either directions of rotation.

3.6.5 The maximum permissible temperature rise over the ambient temperature shall be within the limits specified in IS: 325 (for 3 phase induction motors) after adjustment due to increased ambient temperature specified.

3.6.6 The double amplitude of motor vibration shall be within the limits specified in IS:729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

3.6.7 All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes.

**3.7 AUXILIARY SWITCH**

The auxiliary switch shall conform of following type tests:

a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
c) Heat run test on contacts
d) IR/HV test, etc.

**3.8 LAMPS AND SOCKETS**

3.8.1 Lamps:

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

3.8.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

3.8.3 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

**3.9 SWITCHES & FUSES:**

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switch-fuse units. Selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

All fuses shall be of HRC cartridge type conforming to IS 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal Protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

All control switches shall be of rotary type. Toggle/piano switches shall not be accepted.

### 3.10 TYPE, ROUTINE & ACCEPTANCE TESTS:

All equipments to be supplied shall be of type tested design. During contract stage, bidder shall submit for Owner's approval the reports of all the type tests listed in this specification and carried out within last ten years from the date **28.11.2013**. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have be witnessed by a client.

However if contractor is not able to submit report of the type tests conducted within ten years from the date **28.11.2013** or in the case of type test reports are not found to be meeting the specification requirements, the bidder 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.

### 3.11 CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST:

a) The corona (for 400kV only) and RIV tests shall confirm to the requirements as per Annexure A.
b) The seismic withstand test for 400kV shall conform to requirements as per Annexure B.

### 3.12 Enclosures:

1. ANNEXURE- A - CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST
2. ANNEXURE- B - SEISMIC WITHSTAND TEST
3. ANNEXURE- I – MQP (NTPC format)
4. ANNEXURE- II – QUALITY ASSURANCE FOR SWITCHYARD

**Annexure – A**

**CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**

1.0 **General**

Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and measurement of radio interference voltage ( RIV).

2.0 **Test Levels**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3.0 **Test Methods for RIV:**

3.1 RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference ( CISPR) Publication 16 -1 ( 1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequencies in the range of 0.5 MHZ to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein.

3.3 In measurement of RIV temporary additional external corona shielding may be provided. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85% , 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendations or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to the voltage read by the noise meter.

4.0 **Test Methods for visible Corona**

The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to

130 % of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears.

**Annexure – B**

**SEISMIC WITHSTAND TEST**

The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.

The bidder shall arrange to transport the structure from his contractor's premises / owner's sites for purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.

**ANNEXURE-I**

| MFGR.'s LOGO | MANUFACTURER'S NAME AND ADDRESS | **MANUFACTURING QUALITY PLAN** | | PROJECT : |
|---|---|---|---|---|
| | | ITEM : | QP NO.: | PACKAGE : |
| | | SUB-SYSTEM: | REV.NO.: | CONTRACT NO. : |
| | | | DATE: | MAIN-SUPPLIER: |
| | | | PAGE: …. OF…. | |

| SL. NO | COMPONENT & OPERATIONS | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTUM OF CHECK | | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | | AGENCY | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | M | C / N | | | | | M | C | N | |
| 1. | 2. | 3. | 4. | 5. | 6. | | 7. | 8. | 9. | D* | ** 10. | | | 11. |
| | | | | | | | | | | | | | | |

| MANUFACTURER/ SUB-SUPPLIER | MAIN-SUPPLIER |
|---|---|
| SIGNATURE | |

**LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" ( √ ) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** MANUFACTURER/SUB-SUPPLIER C**:** MAIN SUPPLIER, **N**: NTPC
**P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE,
**CHP:** NTPC SHALL IDENTIFY IN COLUM "N" AS ' W"

FOR NTPC USE

| DOC. NO.: | | REV…… CAT….. |
|---|---|---|
| | | |
| REVIEWED BY | APPROVED BY | APPROVAL SEAL |

**FORMAT NO.: QS-01-QAI-P-09/F1-R1** **1/1** **ENGG. DIV./QA&I**

**SWITCHYARD** **SQE_20**

| Attributes / Characteristics / Items/Components Sub Systems | Make, model, Type & Rating, Test Certificate | Routine & Acceptance Test as per IS / IEC | Functional requirements as per NTPC Specification |
|---|---|---|---|
| Circuit Breaker (IEC:62271-100) | Y | Y | Y |
| Interruptor & hollow insulator (IEC:233/ IS:5284) | Y | Y | Y |
| Isolator (IEC:62271-102) | Y | Y | Y |
| Current Transformer (IEC:60044/BS:3938/IS2705) | Y | Y | Y |
| Capacitor Voltage Tramsformer (IEC:186A / 358/IS3156/IEC60044) | Y | Y | Y |
| Bus Post Insualtor (IEC:168 / 815 / IS:2544) | Y | Y | Y |
| Disc,Pin & String Insualtor (IEC:383 / IS:731) | Y | Y | Y |
| Long Rod Insualtor (IEC:433) | Y | Y | Y |
| Surge Arrestor (IEC:99-4/IS:3070) | Y | Y | Y |
| Hardware fittings for Insulator (IS:2486 / BS:3288) | Y | Y | Y |
| Spacer Clamps & Connector (IS:10162 / 5561) | Y | Y | Y |
| Aluminium Tube (IS:5082 / 2673 / 2678) | Y | Y | Y |
| Wave Trap (IEC:353 / IS:8792 / 8793) | Y | Y | Y |
| Conductor (IS:398-P-II)(V) | Y | Y | Y |
| Galvanised Steel Structures (IS:2062/2629/4759/6745) | Y | Y | Y |
| Vibration Damper (IS:9708) | Y | Y | Y |
| Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906 | Y | Y | Y |
| Control & Relay Panel | Y | Y | Y |
| SF6 Gas filling & evacuating plant | Y | Y | Y |
| SF6 Gas Leak Detector | Y | Y | Y |
| Leakage Current Analyser | Y | Y | Y |
| Nitrogen Gas Filling Device | Y | Y | Y |
| Protection Relays | Y | Y | Y |
| Event Logger | Y | Y | Y |
| Operation Analyser | Y | Y | Y |
| Disturbance Recorder | Y | Y | Y |
| Tariff Metering System | Y | Y | Y |
| Synchronising Trolly | Y | Y | Y |

| Attributes / Characteristics / Items/Components Sub Systems | Make, Type Rating,and Model, Test Certificates | Routine & Acceptance Test as per relevant IS/IEC | Functional requirements as per NTPC Specification |
|---|---|---|---|
| Relay Test Kit | Y | Y | Y |
| LT Switchgear /LT Panels (IEC:947 / IS:13947) | Y | Y | Y |
| Battery IS:1652 | Y | Y | Y |
| Lighting Panels | Y | Y | Y |
| Surge Monitor | Y | Y | Y |

Notes : 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed
Quality Plan indicating the practice and procedure along with relevant supporting
documents during QP finalisation for all items.
2) All major Bought Out Items will be subject to NTPC approval.

ACSR CONDUCTOR - TYPE: MOOSE specifications

Standards

Conformity of the specification for Aluminium conductors for overhead transmission purposes*
as per IS:398 (Part 5):1996 latest

ISI Marked (If "Yes" Select 2 If "No" select 1)* 2

BIS License number - Must Declare (for Non ISI Marked write NA)*

Govt. Organization with which seller is registered* NA

Aluminium wires :Properties and characteristics* as per IS:398 (Part 5):1996 latest

Steel Wire: Properties and characeteristics as prescribed for regular strength steel wire*
as per IS:398 (Part 5):1996 latest

Testing and Inspection protocol* as per IS:398 (Part 5):1996 latest

Type Test, Acceptance test, Routine Tests parameters, test methods and requirements*
as per Cl. 14 of IS:398 (Part 5):1996 latest

Packing and marking* as per Section 4 of IS:398 (Part 5):1996 latest

Steel Drums for packing of finished conductor* as per OEM's drawing

Wooden Drums for packing of finished conductor* as per OEM's drawing

Price variation* Not applicable

Agreed to obtain approval of manufacturing quality plan from buyer before commencement of manufacturing and agreed to follow the same* Yes

All the Annexures attached above are seen and under stood* Not applicable

Transmission Line Parameters

Voltage rating* 400KV

Bundle Configuration*

Construction

Shape of conductor* Stranded

No. of Aluminium wires in conductor (in Nos.)* 54

Aluminium wire diameter, Nominal (in mm)* 3.53 (Minimum: 3.51 mm, Maximum: 3.55 mm)

No.of Steel wires in conductor (in Nos.)* 7

Steel wire diameter, Nominal (in mm)* 3.53 (Minimum: 3.47 mm, Maximum: 3.59 mm)

Steel Core (in Nos.)* 1

No. of of wires on 1st steel layer (in Nos.)* 6

No. of of wires on 1st Aluminium layer (in Nos.)* 12

No. of of wires on 2nd Aluminium layer (in Nos.)* 18

No. of of wires on 3rd Aluminium layer (in Nos.)* 24

Chemical Composition - Aluminium

Minimum Purity of aluminimum (in %)* 99.5

Maximum copper content (in %)* 0.04

Chemical Composition - Steel wires / Rods

528169/2021/TBG-TBG_ENGG

Carbon (in %)* 0.50 to 0.85

Manganese (in %)* 0.50 to 1.10

Phosphorous (in %)* </=0.035

Sulphur (in %)* </=0.045

Silicon (in %)* 0.10 to 0.35

Minimum purity of zinc (in %)* 99.95

Breaking load

Minimum breaking load of strand: Aluminium: Before stranding (in KN)* 1.57

Minimum breaking load of strand: Aluminium: After stranding (in KN)* 1.49

Maximum Resistance of 1 m length of Aluminium strand at 20 deg. C (in Ohm)* 0.002921

Minimum breaking load of strand: Steel: Before stranding (in KN)* 12.86

Minimum breaking load of strand: Steel: After stranding (in KN)* 12.22

Method for tensile testing of steel wire* as per IS:1521:1972 latest

Galvanizing

Zinc used for galvanizing shall be electrolyte high grade zinc* as per IS:209:1992 latet

Methods for testing uniformity of coating of zinc coated articles* as per IS:2633:1986 latest

Hot-Dipped Galvanized Coatings on Round Steel Wire* as per IS:4826:1979 latest

Method for determination of mass of zinc coating on zinc coated iron and steel articles*

Minimum weight of zinc coating per Sq.mm (in gm)* ~~250~~ 260

Minimum number of dips that the galvanised strand can with stand in the standard preece test* 2 of one minute and 1 of half minute

Recommended Practice for Hot-Dip Galvanizing of Iron and Steel* as per IS:2629:1985 latest

Minimum no. of twists in gauge length equal 100 times the dia., of wire which the strand can withstand in the torsion test (after stranding)* 16

Stranded Conductor

Overall diameter (in mm)* 31.77

Sectional area of aluminium (in Sq.mm)* 528.5

Total sectional area (in Sq.mm)* 597

Minimum UTS of the conductor (in KN)* 161.2

Maximum DC resistance of the conductor at 20 deg. C (in Ohm/Km)* 0.05552

Standard Length

Standard length of the conductor (in m)* ~~2100 +5%~~

Linear mass of the conductor, Standard (in Kg/Km)* 2004 (Minimum: 1969 Kg/ Km, Maximum: 2040 Kg/ Km)

Lay Length of Outer Steel Wire

Direction of lay of outer layer* Right hand

Minimum Lay length,1st Steel layer (in mm)* 16 to 18

Minimum Lay length, 1st Aluminimum layer (in mm)* 12 to 14

Minimum Lay length, 2nd Aluminimum layer (in mm)* 11 to 13

Minimum Lay length, 3rd Aluminimum layer (in mm)* 10 to 12

Workmanship

Aluminium and steel strands shall be* Smooth, uniform and free from all imperfections.

After drawing and after stranding aluminium and steel strands shall be free from*

Spills and splits, die marks, scratches, abrasions, etc.,

Finished conductor shall be* Smooth, compact, uniform

The finished conductors shall be free from*

All imperfections including kinks (protrusion of wires), wire cross over, over riding,

The finished conductors free from looseness*

Yes. (free from wire being dislocated by finger/ hand pressure and/ or unusual bangle noise on tapping)

The finished conductors free from material inclusion*

Yes. Free from White rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

The zinc coating shall be*

smooth, continuous, of uniform thickness and and free from imperfetions

The steel strands shall be pre formed and post formed in order*

To prevent spreading of strands in the event of cutting of complete core

Care shall be taken to avoid, damages to galvanisation*

During pre-forming and post forming operation

JOINTS IN WIRES

Aluminium wires during stranding*

No aluminium wire welds made for the purpose of achieving the required conductor length.

Aluminium wires: Individual wires in the outer most layer of the finished conductor.*

Without any joints (No Joints)

Aluminium wires: Individual wires in the inner layers of the finished conductor*

~~Joints permitted (But not more than 4 per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other alu~~

Aluminium wires: Joints shall be made by* Cold pressure butt welding

Aluminium wires: Cold pressure butt welding withstand a stress of*

Not less than the breaking strength of individual strand as per relevat IS/ IEC specifications

Steel Wires: In the finished wire entering into the manufacture of the strand* No joints

Steel Wire: In any length of the completed stranded steel core of the conductor*

No strand joints or strand splices

Materials

Aluminium strands shall be*

Hard drawn from Electrolytic aluminium rods having purity and copper content as specified in the TP.

Steel: The steel wire strands

PACKING

Finished Conductor shall be supplied with* [redacted]

Sealing of finshed conductor* Both end of the conductort sealed.

Drums are returnable* Non returnable

Protection for conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field* Protected

Outer Convering material on the conductor after packing on drums*

Covered with Solid Polypropylene sheet with minimum 5mm thickness

Supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.* Yes ✓

CERTIFICATIONS

Availability of Type test report to prove conformity to the specification*

Yes, from Central Govt. Lab ✓

Seller agreed to submit guaranteed technical particulars (GTP) to the buyer / consingee on demand* Yes ✓

Agree to furnish all the test reports and certificates to the buyer/consignee* Yes ✓

528169/2021/TBG-TBG_ENGG

**ANNEXURE-TQR**

# TECHNICAL PRE- QUALIFICATION REQUIREMENT

**Name of customer: NTPC**

**Name of consultant**: -

**Name of Project**: 3Xz660MW NORTH KARANPURA (ICT-2 SCOPE)

**Name of Item**: ACSR MOOSE CONDUCTOR

| PQR Sr. No | PQR Description | Supporting Document to be attached |
|---|---|---|
| 1. | The Bidder should have supplied at least 1 km of Overhead Conductor cumulatively in any one year during the last 5 years as on the date of Bid Opening of this Tender | a) Copy of Purchase Orders / LR / MDCC / DI |

| Prepared By: | Checked By: | Approved By: |
|---|---|---|
| AKHILESH KUMAR<br>(Dy. Manager/TBEM)<br>18/10/21 | VIVEK KAPIL<br>(Sr. DGM-TBEM)<br>18.10.21 | Aruna Gulati<br>(AGM & Head-Engg.) |