(s) Workmen's Compensation Act, 1923

(t) Workmen's Compensation Rules, 1924

(u) NTPC Safety Rules for Construction and Erection

(v) NTPC Safety Policy

(w) Any other statutory codes / standards / regulations, as may be applicable.

5.02.00 Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

(a) Japanese Industrial Standards (JIS)

(b) American National Standards Institute (ANSI)

(c) American Society of Testing and Materials (ASTM)

(d) American Society of Mechanical Engineers (ASME)

(e) American Petroleum Institute (API)

(f) Standards of the Hydraulic Institute, U.S.A.

(g) International Organisation for Standardization (ISO)

(h) Tubular Exchanger Manufacturer's Association (TEMA)

(i) American Welding Society (AWS)

(j) National Electrical Manufacturers Association (NEMA)

(k) National Fire Protection Association (NFPA)

(l) International Electro-Technical Commission (IEC) / European Norm (EN)

(m) Expansion Joint Manufacturers Association (EJMA)

(n) Heat Exchange Institute (HEI)

5.03.00 Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned else where in the specification together

with the complete word to word translation of the standard that is normally not published in English.

5.04.00 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

5.05.00 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant, equipment, and structural works shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.

5.06.00 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.

**6.00.00 EQUIPMENT FUNCTIONAL GUARANTEE**

6.01.00 The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.

6.02.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.

**7.00.00 DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS**

7.01.00 **Design of Facilities**

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best coordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.02.00 **Maintenance and Availability Considerations**

Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the turbine and equipments, inspection of the steam path and the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the Contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the Contractor for lifting the equipment and accessories covered under the specification.

**8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR**

8.01.00 Contractor may note that this is a Contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

Each main and auxiliary equipment/item of the plant including instruments shall be assigned a unique tag number. The assignment of tag numbers shall be in accordance with KKS system. In all drawings/documents/data sheet etc. KKS tag number of the equipment/item/instrument etc. shall be indicated.

The Contractor shall furnish engineering data/drgs. in accordance with the schedule of information as specified in Technical Specification and data sheet.

8.02.00 The number of copies/prints/floppy discs/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I.

8.03.00 The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following :

(a) **Basic Engineering Documentation**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

(i) System description of all the mechanical, electrical, control & instrumentation & civil systems.

(ii) Technology scan for each system / sub-system & equipment.

(iii) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.

(iv) Optimization studies including thermal cycle optimization.

(v) Sizing criteria of all the systems, sub-systems including various piping systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

(vi) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

(vii) Operation Philosophy and the control philosophy of the equipments / system covered under the scope.

(viii) General Layout plan of the power station incorporating all facilities in Contractor's as well as those in the Employer's scope. This drawing shall also be furnished in the form of floppy discs to the Employer for engineering of areas not included in Contractor's scope.

(ix) Basic layouts and cross sections of the Main Plant Building (various floor elevations), and other areas included in the scope of the Contractor.

(x) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

(xi) The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Employer.

(b) **Detailed Engineering Documents**

(i) General layout plan of the station.

(ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

(iii) Flow diagrams, Process & Instrumentation Diagrams along with write-up and system description.

(iv) Start-up curves for boiler, for various start-ups, viz. cold, warm and hot start-up including combined start up curves for boiler & turbine under cold, warm & hot up start up conditions.

(v) Piping isometric, composite layout and fabrication drawings.

(vi) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

(vii) Technical data sheets for all bought out and manufactured items. Contractor shall use the NTPC specifications as a base for placement of orders on their sub-vendors.

(viii) Detailed design calculations for components, system/sub-system,, piping etc., wherever applicable including sizing calculations for all auxiliaries as per criteria specified elsewhere in specification.

(ix) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.

(x) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable & input and output data along with stress analysis isometrics showing nodes.

(xi) Thermal cycle information (heat balance diagrams, boiler performance calculations, thermal calculations etc.).

(xii) Characteristic Curves/ Performance Correction Curves. Hydraulic & Mechanical design calculations for equipment like pumps, compressors, other heat exchangers & equipments covered under the package.

(xiii) Comprehensive list of all terminal points which interface with Employer's facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

(xiv) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

(xv) Protection system diagrams and relay settings.

(xvi) Interconnection diagrams.

(xvii) Cable routing plan.

(xviii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

(xix) Alarm and annunciation list and alarms & trip set points.

(xx) Sequence and protection interlock schemes.

(xxi) Type test reports and power system stability study report.

(xxii) Control system configuration diagrams and maintenance details.

(xxiii) Detailed software manuals & source software listing.

(xxiv) Detailed flow chart for digital control system.

(xxv) Man Machine Interface application engineering drawings & documents.

(xxvi) Civil & Structural works drawings and documents for all structures, facilities, foundations, underground and overground works and super-structural works as included in the scope of the Bidder.

(xxvii) Model study reports wherever applicable.

(xxviii) Functional & Guarantee test procedures and test reports.

(xxix) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

(xxx) Documentation in respect of commissioning as listed out elsewhere in this specification.

(xxxi) Maintenance schedule for boiler & auxiliaries & ESP clearly indicating interval, duration if shutdown required, man hours required and tools & tackles required for the maintenance.

8.03.01 The Contractor while submitting the above documents / drawings for approval / reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

8.03.02 **Instruction Manuals**

The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Employer the Instruction Manuals shall be submitted as indicated in Annexure-I. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following:

(a) **Erection Manuals**

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

(i) Erection strategy.

(ii) Sequence of erection.

(iii) Erection instructions.

(iv) Critical checks and permissible deviation/tolerances.

(v) List of tool, tackles, heavy equipments like cranes, dozers, etc.

(vi) Bill of Materials

(vii) Procedure for erection.

(viii) General safety procedures to be followed during erection/installation.

(ix) Procedure for initial checking after erection.

(x) Procedure for testing and acceptance norms.

(xi) Procedure / Check list for pre-commissioning activities.

(xii) Procedure / Check list for commissioning of the system.

(xiii) Safety precautions to be followed in electrical supply distribution during erection

(b) **Operation & Maintenance Manuals**

(i) The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Employer to operate, 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, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The Contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Employer.

(ii) If after the commissioning and Trial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Employer for records.

(iii) 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 with all relevant pamphlets and drawings.

(iv) 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.

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

(v) Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc.system/equipment/assembly/sub-assembly - wise required for the complete plant.

(vi) On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Employer indicating lubrication method for each type/category of bearing.

8.03.03 **Plant Handbook**

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

(1) Design and performance data.

(2) Process & Instrumentation diagrams.

(3) Single line diagrams.

(4) Sequence & Protection Interlock Schemes.

(5) Alarm and trip values.

(6) Performance Curves.

(7) General layout plan and layout of main plant building and auxiliary buildings

(8) Important Dos & Don'ts

The plant handbook shall be submitted within twelve (12) months from the date of award of Contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.04 **Project Completion Report**

The Contractor shall submit a Project Completion Report at the time of handing over the plant.

8.03.05 **Drawings**

(a) (i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.

(ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I of Part-C. The soft copies to be supplied shall be uploaded by the vendor in c-folder, a web based system of NTPC ERP, for which a username and password will be allotted to the new vendor by NTPC.

Similarly the vendor can download the drawings/documents, approved/commented by NTPC, through above site.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, pdf, .dwg or .std formats.

(iii) Final copies of the approved drawings along with required number of hard copies shall be submitted as per Annexure-I of Part-C.

(iv) The completed plant documentation including integrated 3D model with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to Employer, along with the design review software which shall include interference check and walk-through animation, loaded on suitable hardware (server and work station). The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter / printer. The requisite hardware and software shall be supplied and commissioned by the Contractor at Employer's Engineering Office Complex at Noida as per mutually agreed schedule.

(b) All documents/text information shall be in latest version of MS Office and MS Excel as applicable.

(c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

(d) Each drawing submitted by the Contractor (including those of subvendors) 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, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(e) The drawings submitted by the Contractor (or their sub-vendors) shall bear Employer's drawing number in addition to Contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

(f) The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

(g) Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.

(h) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and Contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer / Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this Contract.

(i) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.

(j) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

(k) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority / representative of Employer based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

(l) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

(m) As Built Drawings

After final acceptance of individual equipment /system by the Employer, the Contractor will update all original drawings and documents for the equipment/ system to "as built" conditions.

(n) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The Contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The Contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

(o) The Contractor shall submit adequate prints of drawings / data / documents for Employer's review and approval. The Employer shall review the drawings and return one (1) copy to the Contractor authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the Contract schedule.

(p) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the Contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

8.04.00 **Engineering Information Submission Schedule**

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information along with the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

(a) Information that shall be submitted for the approval of the Employer before proceeding further, and

(b) Information that would be submitted for Employer's information only.

The Engineering Information Schedule shall be updated month wise.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the Contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.05.00 **Engineering Progress and Exception Report**

8.05.01 The Contractor shall submit every month an Engineering progress and Exception Report giving the status of each engineering information including

(a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

(b) Drawings which were not submitted as per agreed schedule.

8.05.02 The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the Contract, which shall then be discussed and finalised with the Employer.

8.05.03 Bidder to update Master Drawing List (MDL) monthly and shall be submitted to the Employer in every first week of month.

**9.00.00 TECHNICAL CO-ORDINATION MEETING**

9.01.00 The Contractor shall be called upon to organize and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of Contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

9.02.00 The Contractor should note that Time is the essence of the Contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks from the date of receipt of the drawing .The comments of the Employer shall then be discussed across the table during the above Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.

9.03.00 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the

drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.

9.04.00 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.

9.05.00 Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.

**10.00.00 DESIGN IMPROVEMENTS**

The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

**11.00.00 TRAINING OF EMPLOYER'S PERSONNEL**

11.01.00 **Training for Employers O&M Personnel**

The scope of service under training of Employer's engineers shall include a training module covering upto thirty five (35) man months in the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Employer:

(a) Training for Steam Generator & ESP Equipment & Auxiliaries.

(b) Training for Electric Systems including VFD.

(c) Training for other SG related C&I systems/equipments.

(d) Training for special packages for various PC based systems specified elsewhere in Part-B of Technical Specification, Section-VI.

(e) Training for DDCMIS as detailed in Part-B of Technical Specification, Section-VI.

(f) Training for power cycle piping/critical piping.

11.02.00 **Training for Employers Engineering Personnel**

The scope of services under training shall also necessarily include training of Employer's Engineering personnel covering a training module of upto 15 man months. This shall cover all disciplines viz, Mechanical, Electrical, C&I , QA etc. and shall include all the related areas like Design familiarization, training on product design features and product deign software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing erection, welding etc. An indicative module of the training requirement of Employer's Engineering personnel is attached as Annexure-II.

11.03.00 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Employer's approval. Consolidated training period included above (i.e. 35 & 15 months respectively for O&M and Engineering) is indicative only. Employer reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

11.04.00 Exact details, extent of training and the training schedule shall be finalized based on the Bidder's proposal within two (2) months from placement of award.

11.05.00 In all the above cases, wherever the training of Employer's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Employer's personnel shall be at the cost of Contractor. The Contractor shall make all necessary arrangements towards the same.

11.06.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Employer reserves the right to include or exclude these item(s) during placement of Award.

**Note**: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

**12.00.00 EQUIPMENT BASES**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

**13.00.00 PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

**14.00.00 LUBRICANTS, SERVO FLUIDS AND CHEMICALS**

14.01.00 The Contractor's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the Trial operation and final filling after the Trial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.

14.02.00 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Employer along with lubrication requirements.

**15.00.00 LUBRICATION**

Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

**16.00.00 MATERIAL OF CONSTRUCTION**

All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilised for various components shall be those which have established themselves for use in such applications.

**17.00.00 RATING PLATES, NAME PLATES & LABELS**

17.01.00 Each main and auxiliary item of plant including instruments 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, tag number, 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.

17.02.00 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Employer or as detailed in appropriate section of the technical specifications.

17.03.00 Such nameplates or labels shall be of white non hygroscopic 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. The name plates shall be suitably fixed on both front and rear sides.

17.04.00 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

17.05.00 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

17.06.00 Valves, steam traps and strainers shall be identified by Employer's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

17.07.00 Safety and relief valves shall be provided with the following :

(a) Manufacturer's identification.

(b) Nominal inlet and outlet sizes in mm.

(c) Set pressure in $Kg/cm^2$ (abs).

(d) Blowdown and accumulation as percentage of set pressure.

(e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in liters of water per minute.

17.08.00 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.

17.09.00 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

**18.00.00 TOOLS AND TACKLES**

The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder along with the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and Trial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.

**19.00.00 WELDING**

If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be per formed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.

**20.00.00 COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**

All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.

**21.00.00 PROTECTION AND PRESERVATIVE SHOP COATING**

21.01.00 **Protection**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Part-A & B of the Technical Specification.

21.02.00 **Preservative Shop Coating**

21.02.01 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.

21.02.02 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.

21.02.03 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.

21.02.04 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Employer.

21.02.05 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.

21.02.06 Painting for Civil structures and equipment/system covered under this package shall be done as specified under technical requirements on civil works in relevant part of this specifications.

**22.00.00 PROJECT MANAGER'S SUPERVISION**

22.01.00 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section GCC of Vol.I, the Contractor shall proceed to comply with the Project Manager's decision.

22.02.00 The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

(a) Interpretation of all the terms and conditions of these documents and specifications:

(b) Review and interpretation of all the Contractor's drawing, engineering data, etc:

(c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :

(d) Inspect, accept or reject any equipment, material and work under the contract:

(e) Issue certificate of acceptance and/or progressive payment and final payment certificates

(f) Review and suggest modifications and improvement in completion schedules from time to time, and

(g) Supervise Quality Assurance Programme implementation at all stages of the works.

**23.00.00 QUALITY ASSURANCE PROGRAMME**

23.01.00 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 sub-Contractor'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-9001-2000/IS-14001. A quality assurance programme of the Contractor shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme

(b) Quality System Manual

(c) Design Control System

(d) Documentation and Data Control System

(e) Qualification data for bidder's key personnel.

(f) 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.

(g) System for shop manufacturing and site erection controls including process, fabrication and assembly.

(h) Control of non-conforming items and system for corrective actions and resolution of deviations.

(i) Inspection and test procedure both for manufacture and field activities.

(j) Control of calibration and testing of measuring testing equipment.

(k) System for Quality Audits.

(l) System for identification and appraisal of inspection status.

(m) System for authorising release of manufactured product to the Employer.

(n) System for handling, storage and delivery.

(o) System for maintenance of records, and

(p) 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 enclosed formats no. QS-01-QAI-P09/F1-R1 and QS-01-QAI-P09/F2-R1.

23.02.00 **General Requirements - Quality Assurance**

23.02.01 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 shall 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 as per enclosed format No. QS-01-QAI-P01/F3-R0. Monthly progress reports on MQP/FQP submission/approval shall be furnished as per enclosed format No. QS-01-QAI-P-02/F1-R0.

23.02.02 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 through c-folder, a web based system of NTPC ERP, in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

23.02.03 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.

23.02.04 The Contractor 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. 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 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.

23.02.05 The Contractor shall submit to the Employer Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-CQA-W-11/F1. The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.

23.02.06 The Contractor shall have suitable Field Quality Organisation with adequate manpower at Employer's site, to effectively implement the Field Quality Plan (FQP) and Field Quality Management System for site activities. The contractor shall submit the details of proposed FQA setup (organisational structure and manpower) for employer's approval. The FQA setup shall be in place at least one month before the start of site activities.

23.02.07 No material shall be dispatched from the manufacturer's works before the same is accepted, subsequent to predispatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for dispatch by issuance of Material Dispatch Clearance Certificate (MDCC).

23.02.08 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.

23.02.09 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.

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

23.02.10 All brazers, welders and welding operators employed on any part of the Contract either in Contractor's/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.

23.02.11 Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

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| 23.02.12 | 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 equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding. |
| 23.02.13 | Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only. |
| 23.02.14 | No welding shall be carried out on cast iron components for repair. |
| 23.02.15 | All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes. |
| 23.02.16 | 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.<br><br>All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested. |
| 23.02.17 | 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 sub-Contractors 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 as per enclosed format No. QS-01-QAI-P-01/F3-R0. 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 sub-Contractors 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. Monthly progress reports on sub-Contractor detail submission / approval shall be furnished as per enclosed format no. QS-01-QAI-P-02/F1-R0. Such vendor approval shall not relieve the Contractor from any obligation, duty or responsibility under the Contract. |
| 23.02.18 | 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 sub-Contractor 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. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/Contract between the Contractor and sub-Contractor. With in three weeks of the release of the purchase orders /Contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the Contract.

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

23.02.20 The Contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's 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/equipment 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.

23.02.21 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.

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

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

23.02.24 **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% which ever 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.

(2) **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.

23.03.00 **QA Documentation Package**

The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (□) mark.

23.03.01 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.

23.03.02 Typical contents of QA Documentation is as below:-

(a) Quality Plan

(b) Material mill test reports on components as specified by the specification and approved Quality Plans.

(c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

(d) 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.

(e) Heat Treatment Certificate/Record (Time- temperature Chart)

(f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).

(g) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

(h) Certificate of Conformance (COC) wherever applicable.

(i) MDCC

23.03.03 Similarly, the Contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per

Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

23.03.04 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.

(a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

(b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize 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.

(c) If a decision is made 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.

23.03.05 **Transmission of QA Documentation**

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.

For the particular case of phased/part derivatives of equipment, the complete quality document of that particular equipment to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

23.04.00 **Inspection, Testing and Inspection Certificates**

23.04.01 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.

23.04.02 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.

23.04.03 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 and confirmed in writing, 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.

23.04.04 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.

23.04.05 When the factory tests have been completed at the Contractor's or sub-contractor'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.

23.04.06 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.

23.04.07 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.

23.04.08 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 22.05.03 of this chapter, 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.

23.04.09 All inspection, measuring and test equipment 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 equipment in the presence of Project Manager / Inspector.

23.05.00 **Associated Document for Quality Assurance Programme:**

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| 23.05.01 | List of items requiring Quality Plan & Sub-supplier approval. Format No. | : | QS-01-QAI-P-01/F3-R0 (Annexure-III) |
| 23.05.02 | Status of Quality Plan and Sub-supplier approval Format No. | : : | QS-01-QAI-P-02/F1-R0 (Annexure-IV) |
| 23.05.03 | Field Welding Schedule Format No. | : | QS-01-CQA-W-11/F1-R0 (Annexure-V) |
| 23.05.04 | Manufacturing Quality Plan Format No. | : | QS-01-QAI-P-09/F1-R1 (Annexure-VI) |
| 23.05.05 | Field Quality Plan Format No. | : | QS-01-QAI-P-09/F2-R1 (Annexure-VII) |

**24.00.00 This clause is not used.**

**25.00.00 This clause is not used.**

**26.00.00 PRE-COMMISSIONING AND COMMISSIONING FACILITIES**

26.01.00 (a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-

commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included elsewhere in the Technical Specifications.

(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

(c) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Employer six months prior to the respective implementations. The Employer will approve final verification of cleanliness.

(d) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(e) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SCL (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Employer.

(f) The Contractor during Trial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

(g) Contractor shall furnish the commissioning organization chart for review & acceptance of employer at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain :

(1) Biodata including experience of the Commissioning Engineers.

(2) Role and responsibilities of the Commissioning Organisation members.

(3) Expected duration of posting of the above Commissioning Engineers at site.

26.02.00 **Trial Operation**

(a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Trial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.

(b) The 'Trial Operation' of the complete facility as an integral unit, comprising of SG, Turbine, Generator along with their associated systems / sub systems, shall be conducted for 720 continuous hours. During the above period of Trial Operation, the unit shall generate 342 million KWHrs, as measured at generator terminals. During the period of Trial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

(c) The Trial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Trial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

(d) The Contractor shall intimate the Employer about the commencement of Trial operation and shall furnish adequate notice to the Employer in this respect.

(e) Any loss of generation due to constraints attributable to the Employer shall be construed as Deemed Generation.

(f) A Trial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Trial Operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during Trial operation shall also include the dates of start and finish of the Trial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Trial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Employer to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for with holding the aforesaid permission.

**27.00.00 TAKING OVER**

Upon successful completion of Trial Operations and all the tests, other than Guarantee Tests conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the

equipment. Such certificate shall not unreasonably be with held nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

**28.00.00 GUARANTEE TESTS**

(a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, Start-up Engineer shall make the unit ready to conduct such test. Such test will be commenced, within a period of **three (3) months** after the successful completion of Trial Operations. Any extension of time beyond the above **three (3) months** shall be mutually agreed upon.

(b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

(c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Employer shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Employer's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

(d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Contractor, free of cost.

(e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specification.

**29.00.00 NOISE LEVEL**

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

(a) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.

(b) Regulating drain valves in which case it shall be limited to 90 dBA.

(c) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 85 dBA.

**30.00.00 PACKAGING AND TRANSPORTATION**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

**31.00.00 ELECTRICAL ENCLOSURE**

All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification,

**32.00.00 ELECTRICAL NOISE CONTROL**

The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-61000. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems as per EN-50082-2 (1995).

**33.00.00 INSTRUMENTATION AND CONTROL**

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

33.01.00 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

(a) Temperature - Degree centigrade (deg C)

| | | | |
|---|---|---|---|
| (b) | Pressure | - | Kilograms per square centimetre ($Kg/cm^2$). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure. |
| (c) | Draught | - | Millimetres of water column (mm wc). |
| (d) | Vacuum | - | Millimeters of mercury column (mm Hg) or water column (mm Wcl). |
| (e) | Flow (Gas) | - | Tonnes/ hour |
| (f) | Flow (Steam) | - | Tonnes/ hour |
| (g) | Flow (Liquid) | - | Tonnes / hour |
| (h) | Flow base | - | 760 mm Hg. 15 deg.C |
| (i) | Density | - | Grams per cubic centimetre. |

33.02.00 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

33.03.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.

**34.00.00 INSTRUMENT AIR SYSTEM**

The instrument air supply system as supplied by the Contractor for various pneumatic control & instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc. shall be as per the details furnished elsewhere.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

**35.00.00 TAPPING POINTS FOR MEASUREMENTS**

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Contractor will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Contractor. The standard which is to be adopted, will be intimated to the Contractor.

(a) Temperature test pockets with stub and thermowell

(b) Pressure test pockets

**36.00.00 ELECTRONIC MODULE/COMPONENT DETAILS**

The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc.

It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.

**37.00.00 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

(a) Working platforms should be fenced and shall have means of access.

(b) Ladders in accordance with Employer's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

**ANNEXURE-1**

| S.NO. | DESCRIPTION OF MANUALS | NO OF PRINTS | NO. OF CD-ROMs |
|---|---|---|---|
| 1. | PLANT DEFINITION MANUAL- | 2 sets | 4 CD-ROMs |
| | Drawings "FOR APPROVAL" | | |
| 2. | i) Layout drawings/P&IDs | 6 | 2 CD-ROMs |
| | ii) Other drawings | 2 | 2 CD-ROMs |
| 3. | Drawings "FOR INFORMATION" | 2 | 2 FLOPPIES |
| 4. | Drawings "FINAL DRAWING" | 15 | 4 CD-ROMs |
| 5. | Drawings "AS BUILT " | 15 | 4 CD-ROMs |
| 6. | DATASHEETS, DESIGN CALCULATIONS, PURCHASE SPECIFICATIONS, etc. and Other type of documents | | |
| | i) For Approval | 2 | 2 CD-ROMs |
| | ii) FINAL | 15 | 4 CD-ROMs |
| | iii) Analysis reports of equipments/ piping/ structures components/ systems employing software packages as detailed in the specifications | 2 | 2 CD-ROMs |
| 7. | Erection manual "DRAFT" | 4 sets | 2 CD-ROMs |
| 8. | Erection manual "FINAL" | 4 sets | 4CD ROMS |
| 9. | Operation & Maintenance manual "IST SUBMITTIOM" | 4 sets | 2 CD-ROMs |
| 10. | Operation & Maintenance manual "FINAL" | 4 sets | 4CD ROMS |
| 11. | Plant Hand Book "IST SUBMITTIOM" | 4 sets | 2 CD-ROMs |
| 12. | Plant Hand Book "FINAL" | 4 sets | 4CD ROMS |
| 13. | Commissioning and Performance "IST SUBMITTIOM" | 4 sets | 2 CD-ROMs |
| 14. | Commissioning and Performance "FINAL" | 4 sets | 4 CD-ROMs |
| 15. | Performance and Functional guarantees test report | 4 sets | 4 CD ROMS |
| 16. | Project completion report | 15 | 4CD ROMS |
| 17. | QA programme including Organization for implementation and QA system manual (with revision-servicing) | 1 | 1 CD ROM |
| 18. | Vendor details in respect of proposed vendors including contractor's evaluation report. | 1 | 1 CD ROM |
| 19. | Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, PQR etc. | | |

| S.NO. | DESCRIPTION OF MANUALS | NO OF PRINTS | NO. OF CD-ROMs |
|---|---|---|---|
| | i) For review/comment | 2 | 2 CD ROM |
| | ii) For final approval | 2 | 2 CD ROM |
| 20. | Welding Manual, Heat Treatment Manuals, Storage & preservation manuals | | |
| | i) 1st submittion | 4 sets | 2 CD ROM |
| | ii) Final | 4 sets | 4 CD ROM |
| 21. | QA Documentation Package for items / equipment manufactured and dispatched to site | 2 sets | 4CD ROMS |
| 22. | QA Documentation Package for field activities on equipment / systems at site | 2 sets | 4 CD ROMS |

ANNEXURE - II

| PRODUCT | AREAS OF TRAINING REQUIEMENT | | | |
|---|---|---|---|---|
| | **PRODUCT DESIGN** | **Plant Visit** | **Visit to Manufacturer's Work** | **Operation & Maintenance of Plant** |
| **Steam Generator** | Thermal design and hydraulic circulation balance<br><br>Combustion and Air & gas weight calculation<br><br>Pressure part calculation<br><br>Pressure parts and strength calculation<br><br>Tube metal temp. calculation and selection<br><br>Performance<br><br>Duct design<br><br>Pressure parts arrangement<br><br>Equipment and system sizing and selection of mills, fans, airpreheater, soot blowers, dampers, valves heater, soot blowers, dampers, valves, feeders, burners startup system, fuel firing system, fuel firing system, draft plant.<br><br>Flow scheme development of air & flue gas, fuel oil, auxiliary steam, main and reheat steam feed water. | Familiarization with various system and equipment<br><br>Performance data collection analysis and review<br><br>O&M feed back<br><br>Operation history of various equipments and system<br><br>Failure analysis | Manufacturing process of pressure parts, and equipments<br><br>Welding process<br><br>Testing facilities<br><br>Product development in process<br><br>Future plan for technology induction<br><br>R&D work in progress | Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues.<br><br>Familiarization of special maintenance techniques<br><br>Special tool and tackles familiarization |

| | | | | |
|---|---|---|---|---|
| | **PRODUCTION DESIGN**<br><br>Layout of over all plant, steam generator area, pressure part arrangements, platforms, equipment, piping and duct, coal pipe, flue gas ducts, bunker arrangement, valves and damper, ESP area, cable & piping trestles etc.<br><br>Erection strategies, erection procedures<br><br>Performance and demonstration tests. | | | |
| **MANDAYS** | **120** | **20** | **20** | 20 |
| **CONTROL & INSTRUMENTATION**<br><br>DDCMIS*-Human Machine Interface - Hardware & Operating System | Hardware & Software organization of the system<br><br>Basis of selection of H/W memory Sizing<br><br>Operating system features, interface with other system, openness & inter-operability<br><br>Upgradability<br><br>System testing features | Operational feedback | | |
| **MANDAYS** | **16** | **6** | | |

| | | | | |
|---|---|---|---|---|
| DDCMIS*-Human Machine Interface System Engineering & Application Software | Specific system customization<br><br>Various system modules & interface with OS<br><br>Database organization & development<br><br>Development of mimics<br><br>Other application like calculations, logs historical storage functionalities & use | Operation feedback | | |
| **MANDAYS** | **40** | **6** | | |
| DDCMIS* - Control System Hardware | Basic design features for system & its Modules<br><br>System capabilities & system design Techniques<br><br>Communication with HMI & other System | Operation feedback | Manufacturing processes special attention to handling of the modules<br><br>Maintenance facilities | |
| **MANDAYS** | **20** | **5** | **10** | |
| DDCMIS*-Control system Application Software | Database structure Organisation & interface between application program & database<br><br>Application for implementation of Control functions<br><br>Study of standard algorithms & development of new algorithm | Operational feedback | System integration & System capabilities testing | |
| **MANDAYS** | **12** | **4** | **4** | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| DDCMIS* - Control Loop Study | General description of closed loop controls of thermal power plant<br><br>Critical analysis of few control loops e.g., boiler start up control etc. | Specific operational feedback | | |
| **MANDAYS** | **4** | **2** | | |
| DDCMIS*-Burner Management Study | Hardware logic, NFPA/VDE requirements & other safety standards<br><br>Flame scanner location | Operational feedback | Manufacturing procedure & precautions for handling the system<br><br>System testing facilities | |
| **MANDAYS** | **10** | **3** | **3** | |
| Boiler Flame Viewing system<br>----------<br>Misc. system for SG C&I | Theory & principle of operation<br><br>Details of software & methods of modification/customisation | Operational feedback | | |
| **MANDAYS** | **6** | **3** | | |
| Electric Power Supply System | Theory & design features | | Manufacturing/assembly process<br><br>Testing Methodology | |
| **MANDAYS** | **5** | **2** | | |
| Wherever "DDCMIS" is indicated, it will mean SG C&I part of DDCMIS, which is in Contractor's Scope. | | | | |
| **MANDAYS** | **45** | **10** | **10** | |

| | | | | |
|---|---|---|---|---|
| **QUALITY ASSURANCE & INSPECTION**<br><br>**QA SYSTEM & PROGRAMME** | Integrated QA Management System for enhanced reliability of equipments.<br><br>• QA system in design, procurement, manufacturing, installation and operation of the equipments/ systems.<br><br>• QA system for developing and establishing new processes and vendors.<br><br>• System of structured documentation of Engg. And test records | Operating feed backs:<br><br>• Co-relation of reliability and performance of the equipment with implementation of QA system.<br><br>• Appreciation of use of structured Engg./QA documentation during Operational phase of plant and during RLA studies of plant | • Appreciation of implementation of QA Programmes in various manufacturing, assembly and testing activities.<br><br>• Appreciation of developmental activities for new processes and vendors.<br><br>• System of prequalification of special processes. | |
| **MANDAYS** | **20** | **10** | **26** | |
| CONTROLS & INSTRUMENTS | Familiarization with control system and instrumentation<br><br>QA system for manufacture of reliable components | Feedback on performance of C&I System | Manufacturing activities for critical instruments/Items<br><br>Implementation of testing programme to ensure reliability. | |
| **MANDAYS** | **6** | **4** | **4** | |

ANNEXURE-III

| | | | |
|---|---|---|---|
| Project : | Stage : | LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL | DOC. NO.: |
| Package : | | | REV. NO.: |
| Supplier : | | | DATE : |
| Contractor No. : | | SUB-SYSTEM : | PAGE : OF |

| S. No. | Item | QP/ Insp. Cat. | QP No. | QP Sub. Schedule | QP approval schedule | Proposed sub-supplier | Place | Sub-suppliers approval status/ category | Sub-supplier Details submission schedule | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
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**LEGENDS**

**1. SYSTEM SUPPLIER / SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)**

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.

NOTED– For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED.'

**2. QP/INSPN CATEGORY:**

CAT-I : For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.

CAT-II : For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.

**UNITS/WORKS** : Place of manufacturing Place of Main Supplier of multi units/works.

| | | |
|---|---|---|
| **FORMAT NO.: QS-01-QAI-P-1/F3-R0** | 1/1 | Engg. Div. / QA&I |

ANNEXURE-IV

| | | | |
|---|---|---|---|
| Project : | Stage : | STATUS OF ITEM REQUIRING QP & SUB-SUPPLIER APPROVAL | DOC. NO.: |
| Package : | | | REV. NO.: |
| Contractor : | | | DATE : |
| Contractor No. : | | | PAGE : OF |

| S. N. | Item / Service | QP/ Insp. Cat. | QP Sub. Schedule Approval schedule | Date of sub-mission | Date of commt Appl. | Status Code C/II/I | Proposed Sub-suppliers | Place of manufacturing works | Approval Status | Sub-supplier detail submission schedule | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

| | | |
|---|---|---|
| FORMAT NO.: QS-01-QAI-P-02/F1-R0 | 1/1 | Engg. Div. / QA&I |

ANNEXURE-V

| | | | |
|---|---|---|---|
| Project : | Stage : | FIELD WELDING SCHEDULE<br>(To be raised by the contractor)<br>Welding Code: ..... | DOC. NO.: |
| Contractor : | | | REV. NO.: |
| Contractor No. : | | | DATE : |
| System : | | | PAGE : OF |

| Sl. No. | DRG No. for Weld Location and Identification mark | Description of parts to welded | Matl. Spec | Dimensions | | Process of welding | Type of Weld | Electrode filler spec. | WPS. No. | Min. pre-heat | Heat treatment | | NDT method/ Quantum | REF | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Temp. | Holding time | | Spec. No. | ACC Norm Ref. | |
| | | | | | | | | | | | | | | | | |

NOTES:

SIGNATURE

| | | |
|---|---|---|
| Format No.: QS-01-CQA-W-11/F1-R0 | 1/1 | Engg. Div. / QA&I |

ANNEXURE-VI

| 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 | **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..... | | |
| SIGNATURE | | | | REVIEWED BY | APPROVED BY | APPROVAL SEAL |

Format No.: QS-01-QAI-P-09/F1-r1 1/1 Engg. Div./QA&I

ANNEXURE-VII

| SUPPLIER'S LOGO | SUPPLIER'S NAME AND ADDRESS | FIELD QUALITY PLAN | | PROJECT :<br>PACKAGE :<br>CONTRACT NO. :<br>MAIN-SUPPLIER : |
|---|---|---|---|---|
| | | ITEM :<br><br>SUB-SYSTEM: | QP NO.:<br>REV. NO.:<br>DATE:<br>PAGE: .... OF.... | |

| SL. NO | ACTIVITY AND OPERATION | CHARACTERISTICS / INSTRUMENTS | CLASS OF CHECK # | TYPE OF CHECK | QUANTUM OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | D* | 10. |
| | | | | | | | | | | |

| | | | | Doc. No. | Rev. ... |
|---|---|---|---|---|---|
| MANUFACTURER/ SUB-SUPPLIER | MAIN-SUPPLIER | LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.<br>LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;<br>'A' SHALL BE WITNESSED BY NTPC FQA, 'B' SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND 'C' SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE) | FOR NTPC USE | | |

| SIGNATURE | | | REVIEWED BY | APPROVED BY | APPROVAL SEAL |
|---|---|---|---|---|---|

FORMAT NO.: QS-01-QAI-P-09/F2-R1 1/1 ENGG. DIV./QA&I

# NTPC LIMITED

## 1X500 MW VINDHAYACHAL STPS, STAGE-V, UNIT NO.- 13

# VOLUME IIB

# TECHNICAL SPECIFICATION
# FOR
# FUEL OIL UNLOADING & STORAGE SYSTEM

## SPECIFICATION NO.: PE-TS-389-166-A001
## (ELECTRICAL PORTION)

## BHARAT HEAVY ELECTRICALS LTD

## POWER SECTOR PROJECT ENGINEERING MANAGEMENT
## PPEI,NOIDA-INDIA

1.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER :**

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Erection and Commissioning spares.
e) Erection & Maintenance tools & tackles.
f) Electrical load requirement for Fuel Oil Unloading and Storage System.
g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL
i) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:
Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

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

a) A copy of this sheet "Electrical equipment Specification for Fuel Oil Unloading and Storage System" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
b) List of Erection and Commissioning spares.
c) List of Erection & Maintenance tools & tackles.
d) Electrical load requirement

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

4.0 List of enclosures :
a) Specification AC Motors, LT power, LT Control & Instrumentation cable.
b) Data sheet of AC Motors.
c) Quality Plan.
d) Load data format.

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : FUEL OIL UNLOADING AND STORAGE SYSTEM

PROJECT: 1X500MW VINDHYACHAL STPP STAGE-V

| S.NO | DETAILS | SCOPE SUPPLY | SCOPE E&C | REMARKS |
|---|---|---|---|---|
| 1 | 415 V Switchgear | NTPC | NTPC | 415 V AC/240 V AC supply shall be provided by NTPC based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. DC supply (battery bank, charger etc) and any other supply as required for PLC/control panel (as applicable) shall be provided by vendor. |
| 2 | Local Push Button Station ( for motors) | NTPC | NTPC | Located near the motors. |
| 3 | Power cables, control cables and screened control cables<br><br>a) both end equipment in vendor's scope<br>b) one end equipment in vendor's scope & one end in NTPC's scope.<br>c) one end equipment in Vendor's scope & one end in BHEL scope. | <br><br>Vendor<br>NTPC<br><br>BHEL | <br><br>Vendor<br>NTPC<br><br>vendor | Sizes and quantity of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL/NTPC). Finalisation of cable sizes shall be done by NTPC. Vendor shall provide lugs & glands accordingly. |
| 4 | Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc | Vendor | Vendor | |
| 5 | Cable trays, accessories & cable trays supporting system<br><br>a) for cables in main route<br>b) for cables in branch route | <br><br>NTPC<br>vendor | <br><br>NTPC<br>vendor | |
| 6 | Cable glands and lugs for equipments supplied by Vendor | Vendor | Vendor | 1. Double compression Ni-Cr plated brass cable glands<br>2. Solder less crimping type heavy duty tinned copper lugs for power cables<br>3. solder less crimping type heavy duty copper lugs for control cables. |
| 7 | Conduit and conduit accessories for cabling between equipments supplied by vendor | Vendor | Vendor | Cabling shall be through conduits. However vendor can use the trunk route where available for laying of cables. Conduits shall be supplied by vendor and shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to NTPC/ BHEL approval at contract stage. |
| 8 | Lighting | NTPC | NTPC | |
| 9 | Equipment grounding | NTPC | NTPC | |
| 10 | Lightning protection | Vendor | Vendor | |
| 11 | Below grade grounding | NTPC | NTPC | |

| | | | | |
|---|---|---|---|---|
| 11 | Motors with base plate and foundation hardware | Vendor | Vendor | Makes shall be subject to NTPC/ BHEL approval at contract stage. |
| 12 | Mandatory spares | Vendor | - | Vendor to quote as per specification. |
| 13 | Recommended O & M spares, E & C spares, erection & maintenance tools & tackle | Vendor | - | |
| 14 | Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system). | Vendor | Vendor | |
| 15 | a) Input cable schedules (C & I)<br>b) Cable interconnection detail for the above<br>c) Cable block diagram | Vendor<br>Vendor<br>Vendor | -<br>-<br>- | Cable listing for control cables for vendor supplied equipment (soft copies in the NTPC cable schedule format) shall be furnished during detail engineering by vendor. |
| 16 | Equipment layout drawings | Vendor | - | For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable routing details marked on the drawing as per PEM interface comments. Electrical equipment layout drawing shall be to NTPC approval. |
| 17 | Electrical equipment GA drawing | Vendor | - | |

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/NTPC after award of contract.
2. All QPs shall be subject to approval of BHEL/NTPC after award of contract without any commercial implication.

| LOAD TITLE | RATING (KW / A) | | UNIT (U)/STN (S) | Nos. | | VOLTAGE CODE* | FEEDER CODE** | EMER. LOAD (Y) | CONT.(C)/ INTT.(I) | STARTING TIME >5 SEC (Y) | LOCATION | BOARD NO. | CABLE | | BLOCK CABLE DRG. No. | CONTROL CODE | REMARKS | LOAD No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NAME PLATE | MAX. CONT. DEMAND (MCR) | | RUNNING | STANDBY | | | | | | | | SIZE CODE | NOs | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| ANNEXURE-II | | | | | | | | | | | | | | | | | | |
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NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

| | | | | | | |
|---|---|---|---|---|---|---|
| बी एच ई एल | LOAD DATA (ELECTRICAL) | JOB NO. | | ORIGINATING AGENCY | | PEM (ELECTRICAL) |
| | | PROJECT TITLE | | NAME | | DATA FILLED UP ON |
| | | SYSTEM | FO System | SIGN. | | DATA ENTERED ON |
| | | DEPTT. / SECTION | ELECTRICAL | SHEET 1 OF 1 | REV. 00 | DE'S SIGN. & DATE |

# MOTORS

## MOTORS

**1.00.00 GENERAL REQUIREMENTS**

1.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.02.00 All equipments shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

1.03.00 Contractor shall provide fully compatible electrical system, equipments, accessories and services.

1.04.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.05.00 The auxiliary AC voltage supply arrangement shall have 11kV, 3.3 kV and 415V systems and DC voltage shall be 220 V. It shall be designed to limit voltage variations as given below under worst operating condition :

| | | |
|---|---|---|
| (a) | 11kV, 3.3 kV | +/- 6% |
| (b) | 415/240V | +/- 10% |
| (c) | 220 V DC | -15% to +10%. However the nominal continuous DC power supply shall be 242V. |

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

| | | |
|---|---|---|
| a) | Upto 0.2KW | : Single phase 240V AC / 3 phase 415V AC |
| b) | Above 0.2KW and upto 200KW | : 3 phase 415V AC(Except for motor of DMCW pump for TG auxiliaries which shall be fed from 3.3 KV Three phase) |
| c) | Above 200KW and upto 1500 KW | : 3.3 kV |
| d) | Above 1500 KW | : 11 kV |

1.07.00 Fault level shall be limited to 40kA RMS for 1 second for 11kV & 3.3 kV system and 45 kA RMS 1 second for 415V system. 415V system shall be solidly grounded and 220 VDC system shall be isolated type.

1.08.00 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.

1.09.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances shall be of the contractor.

1.10.00 Degree of Protection

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

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

2.00.00 **CODES AND STANDARDS**

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

3.00.00 **TYPE**

3.01.00 **AC Motors:**

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

b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be Energy Efficient motors, Efficiency class-Eff 1, conforming to IS 12615 or High efficiency (IE2) as per IEC:60034-30.

c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

| | |
|---|---|
| 3.02.00 | DC Motors Shunt wound. |
| 4.00.00 | RATING |
| | (a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor. |
| | (b) Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations. |
| | (c) For BFP motors starting MVA shall be restricted to 58 MVA. |
| 5.00.00 | TEMPERATURE RISE |
| | **Air cooled motors** |
| | 70 deg. C by resistance method for both thermal class 130(F) & 155(F) insulation. |
| | **Water cooled** |
| | 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation. |
| | 41 deg.C over inlet cooling water maximum temperature of 39 deg.C for thermal class Y wet wound Boiler circulation pump motor. |
| 6.00.00 | OPERATIONAL REQUIREMENTS |
| 6.01.00 | **Starting Time** |
| 6.01.01 | For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time. |
| 6.01.02 | For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time. |
| 6.01.03 | For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time. |

6.01.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

6.02.00 **Torque Requirements**

6.02.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

6.02.02 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

6.03.00 **Starting voltage requirement**

(a) 85% below 110 KW

(b) 80% from 110 KW to 200 KW

(c) 85% above 200 KW to 1000 KW

(d) 80% from 1001 KW to 4000 KW

(e) 75% > 4000KW

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

7.00.00 **DESIGN AND CONSTRUCTIONAL FEATURES**

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

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

| | | |
|---|---|---|
| (a) | Fuel oil area | : Group – IIB |
| (b) | Hydrogen generation plant area | : Group - IIC (or Group-I, Div-II as per NEC) |

7.03.00 Winding and Insulation

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

(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature. However the conveyor motor shall be suitable for 3 consecutive hot starts.

(c) 11kV & 3.3 kV AC motors :

Thermal class 155 (F) insulation.

The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15

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

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

7.05.00 Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

7.06.00 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

7.07.00 In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors.

7.08.00 Motor body shall have two earthing points on opposite sides.

7.09.00 HT motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided. In case cable box is offered, then Employer shall provide

termination kit. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.

7.10.00 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

7.11.00 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

7.12.00 The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.

7.13.00 For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

7.14.00 11kV and 3.3 kV motor Terminal Box shall be suitable for fault level of 750MVA for 0.12 sec and 250 MVA for 0.12 sec respectively. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.

7.15.00 The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.

8.00.00 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.

| | | |
|---|---|---|
| (a) Below 110KW | : | 10.0 |
| (b) From 110 KW & upto 200 KW | : | 9.0 |
| (c) Above 200 KW & upto 1000KW | : | 10.0 |
| (d) From 1001KW & upto 4000KW | : | 9.0 |
| (e) Above 4000KW | : | 6 to 6.5 |

**10.00.00 TYPE TEST**

**10.01.00 HT MOTORS**

10.01.01 The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII-(BPS) and the same shall be considered for the evaluation of the bids. The type

tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.

10.01.02 The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

10.01.03 In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the owner for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.

10.01.04 Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED"and carried out within last ten years from the date of bid opening. These reports

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

10.01.05 LIST OF TYPE TESTS TO BE CONDUCTED

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

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

(b) Measurement of noise at no load.

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

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

(e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

(f) Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15

(g) Surge-withstand test on interturn insulation shall be as per clause no. 5.1.2 of IEC 60034, part-15

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

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

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

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

10.02.00 **LT Motors**

10.02.01 LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

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

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

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

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors ( in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip .
5. Temperature rise test .
6. Momentary excess torque test.
7. High voltage test .
8. Test for vibration severity of motor.
9. Test for noise levels of motor(Shall be limited as per clause no 7.06.0C of this section)
10. Test for degree of protection and
11. Overspeed test.

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

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

TABLE – I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

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

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

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

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

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

## SPECIFIC ELECTRICAL REQUIREMENT FOR FUEL OIL UNLOADING AND STORAGE SYSTEM

| SL.NO. | PARAMETERS | UNIT | VINDHYACHAL STAGE-V | | |
|---|---|---|---|---|---|
| | **MOTOR** | | | | |
| 1 | DESIGN AMBIENT TEMP | DEG. C | 50 | | |
| 2 | VOLTAGE SUPPLY AND VARIATION | VOLT | 415V, ± 10% | | |
| 3 | FREQUENCY WITH VARIATION | Hz | 50, +3% & -5% | | |
| 4 | COMBINED VOLTAGE & FREQUENCY VARIATION | | 10% | | |
| 5 | MAX ACCEPTABLE RATING OF MOTOR AT 415 V | KW | Below 200 KW | | |
| 6 | SYSTEM FAULT LEVEL AND ITS DUARTION | KA | 45 KA, 1 Sec | | |
| 7 | SUTABILITY OF TERMINAL BOX FOR FAULT LEVEL AND DURATION | | 50 KA, 0.2 sec | | |
| 8 | CLASS OF INSULATION & TEMP RISE LIMITED TO | | Class-F and temp rise limited to Class-B | | |
| 9 | MIN. STARTING VOLTAGE | | 1) 85% for below 110 KW<br>2) 80% from 110 KW to 200 KW | | |
| 10 | MOTOR RATING FOR SINGLE PHASE SUPPLY | | 0.2 kW & Below | | |
| 11 | MAXIMUM LOCKED ROTOR CURRENT | % OF FLC | 600% ± IS tolerance | | |
| 12 | ACCEPTABLE NOISE LEVEL | DB | 85dB at 1.5m | | |
| 13 | TYPE OF STARTER PROVIDED IN MCC | | DOL | | |
| 14 | DOP OF ENCLOSURE | | IP- 55 | | |
| 15 | SPACE HEATER REQUIREMENT | <30kW | 30KW & ABOVE | | |
| 16 | PAINT SHADE | | RAL 5012 (Blue) | | |
| 17 | SPECIAL REQUIREMENT | | TYPE TEST REPORTS MORE THAN 5 YEARS OLD ARE NOT ACCEPTABLE | | |

| Clause No. | MOTORS |
|---|---|
| | .....<br>(Bidder's Name) |
| DE-1B | **LT MOTORS** |
| | **A. GENERAL** |
| | 1. Manufacturer & Country of origin. (Shall be as per approved QA make) |
| | 2. Equipment driven by motor |
| | 3. Motor type |
| | 4. Quantity |
| | **B. DESIGN AND PERFORMANCE DATA** |
| | 1. Frame size |
| | 2. Type of duty |
| | 3. Type of enclosure /Method of cooling/Degree of protection |
| | 4. Applicable standard to which motor generally conforms |
| | 5. Efficiency class as per IS 12615 |
| | 6. (a) Whether motor is flame proof Yes/No |
| | (b) If yes, the gas group to which it conforms as per IS:2148 |
| | 7. Type of mounting |
| | 8. Direction of rotation as viewed from DE END |
| | 9. Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard (KW) |
| | 10. Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW) |

| Clause No. | MOTORS |
|---|---|
| | ..... (Bidder's Name) |
| | 11. Maximum continuous load demand of driven equipment in KW |
| | 12. Rated Voltage (volts) |
| | 13. Permissible variation of : |
| | a. Voltage (Volts) |
| | b. Frequency (Hz) |
| | c. Combined voltage and frequency |
| | 14. Rated speed at rated voltage and frequency(RPM) |
| | 15. At rated Voltage and frequency: |
| | a. Full load current |
| | b. No load current |
| | 16. Power Factor at |
| | a. 100% load |
| | b. NO load |
| | c. Starting. |
| | 17. Efficiency at rated voltage and frequrecy, |
| | a. 100% load |
| | b. 75% load |
| | c. 50% load |
| | 18. Starting current (amps) at |
| | a. 100 % voltage |
| | b. 85% voltage |

.....
(Bidder's Name)

c. 80% voltage

19. Minimum permissible starting Voltage (Volts)

20. Starting time with minimum permissible voltage

a. Without driven equipment coupled

b. With driven equipment coupled

21. Safe stall time with 100% and 110% of rated voltage

a. From hot condition

b. From cold condition

22. Torques :

a. Starting torque at min. permissible voltage(kg-mtr.)

b. Pull up torque at rated voltage.

c. Pull out torque

d. Min accelerating torque (kg.m) available

e. Rated torque (kg.m)

23. Stator winding resistance per phase (ohms at 20 Deg.C.)

24. $GD^2$ value of motors

25. No of permissible successive starts when motor is in hot condition

.....
(Bidder's Name)

26. Locked Rotor KVA Input

27. Locked Rotor KVA/KW

28. Vibration limit :Velocity (mm/s)

29. Noise level limit (dBA)

**C. CONSTRUCTIONAL FEATURES**

1. Stator winding insulation

   a. Class & Type

   b. Winding Insulation Process

   c. Tropicalised (Yes/No)

   d. Temperature rise over specified maximum ambient temperature of 50 deg C

   e. Method of temperature measurement

   f. Stator winding connection

2. Main Terminal Box

   a. Type

   b. Location (viewed from NDE side)

   c. Entry of cables(bottom/side)

   d. Recommended cable size (To be matched with cable size envisaged by owner)

   e. Fault level (MVA), Fault level duration (sec)

   f. Cable glands & lugs details (shall be suitable for power cable)

.....
(Bidder's Name)

3. Type of DE/NDE Bearing

4. Motor Paint shade

5. Weight of

   a. Motor stator (KG)

   b. Motor Rotor (KG)

   c. Total weight (KG)

**D. List of accessories.**

1. Space Heaters (Applicable for 30 KW & above motor) (Nos./Power in watts/supply voltage)

2. Terminal Box for Space Heater (Yes/No)

3. Speed switch (Yes/No) No of contacts and contact ratings of speed switch

4. Insulation of bearing (Yes/No)

5. Noise reducer(Yes/No)

6. Grounding pads

   i) No and size on motor body

   ii) Nos on terminal Box

7. Vibration pads

   i) Nos and size

   ii) Location

8. Any other fitments

.....
(Bidder's Name)

**E. List of curves.**

1. Torque speed characteristic of the motor
2. Thermal withstand characteristic
3. Starting. current Vs. Time
4. Starting. current Vs speed
5. P.F. and Effi. Vs Load

**F. Additional Data to be filled for each rating of DC Motor**

1. Rated armature voltage (Volt)
2. Rated field excitation (Amp)
3. Permissible % variation in voltage
4. Minimum Permissible Starting voltage (volt)
5. At rated voltage
   - i) Full load Armature current.(Amp)
   - ii) Full load Field current (Amp)
   - iii) No load Armature current (Amp)
6. Full load Field current (Amp)
7. No load Aramature current (Amp)
8. Minimum permissible field current(Amp) to avoid overspeeding at
   - i) Maximum permissible voltage

| Clause No. | MOTORS |
|---|---|
| | ..... (Bidder's Name)<br><br>ii) Rated voltage<br><br>iii) Minimum Permissible Voltage<br><br>9. Resistance (indicative Values) in ohm<br><br>i) Armature winding (Arm + IP + Series) at 25 deg.C<br><br>ii) Field Winding at 25 deg. C<br><br>10. Inductance (indicative values)<br><br>i) Armature winding<br><br>ii) Field winding<br><br>11. Value of trimmer resistance (ohm) to be connected in series with the shunt field to obtain rated speed at<br><br>i) 220 V DC<br><br>ii) 250 V DC<br><br>iii) 187 V DC<br><br>12. Value of the external resistance (ohm) required to be connected in series with armature during starting only<br><br>13. Technical data sheet for external resistance box<br><br>14. GA drawing of motor<br><br>15. Starting time calculation<br><br>16. Starter resistance design calculation<br><br>17. Electrical connection diagram of motor |

# L.T. POWER CABLES

| | |
|---|---|
| VINDHYACHAL SUPER THERMAL POWER PROJECT<br>STAGE-V (1X500 MW)<br>STEAM TURBINE GENERATOR PACKAGE | TECHNICAL SPECIFICATIONS<br>SECTION-VI<br>PART-B |

## LT POWER CABLES

**1.00.00 CODES & STANDARDS**

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

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

**2.00.00 TECHNICAL REQUIREMENTS**

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

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

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

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

2.05.00 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.

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

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

2.06.01 The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm $mm^2$ per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.

2.06.02 The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire /

formed wire. Zinc rich paint shall be applied on armour joint surface of G.S.wire/ formed wire.

2.07.00 Outer sheath shall be of PVC as per IS: 5831 & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

(a.) Oxygen index of min. 29 (as per IS 10810 Part-58).

(b.) Acid gas emission of max. 20% (as per IEC-754-I).

(c.) Smoke density rating shall not be more than 60 % (as per ASTMD-2843).

2.08.00 Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue and Black

2.09.00 For reduced neutral conductors, the core shall be black.

2.10.00 In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

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

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

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

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

2.11.00 All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

2.12.00 Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum, over the declared value in the technical data sheets.

2.13.00 In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

**3.00.00 CABLE SELECTION & SIZING**

3.01.00 LT Power cables shall be sized based on the following considerations:

(a) Rated current of the equipment

(b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage

(c) Short circuit withstand capability

This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse.For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.

(d) The minimum conductor size shall be 6 sqmm for aluminium conductor cables and 2.5 sqmm for copper conductor cables. The constructional details of copper conductor cables shall be same as indicated for copper control cable.

302.00 Derating Factors

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

a) Variation in ambient temperature for cables laid in air

b) Grouping of cables

c) Variation in ground temperature and soil resistivity for buried cables.

3.03.00 Cable lengths shall be considered in such a way that straight through cable joints are avoided.

3.04.00 Cables shall be armoured type if laid in switchyard area or directly buried.

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

**4.00.00** **CONSTRUCTIONAL FEATURES**

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

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

**5.00.00** **CABLE DRUMS**

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

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

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

**5.00.00** **TYPE TESTS**

5.01.00 General

All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the

test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

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

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

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

5.02.00 **Type Tests**

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

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

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

| | | | |
|---|---|---|---|
| | 23. | Smoke density test | For outer sheath only |
| | 24. | Acid gas generation test | For outer sheath only |
| | | **For completed cables** | |
| | 25. | Insulation resistance test | |
| | | (Volume resistivity method) | |
| | 26. | High voltage test | |
| | 27. | Flammability test as per IEC-332 Part-3 (Category-B) | |
| 5.02.02 | **Acceptance Tests** (as per QA table) | | |
| 5.02.03 | **Routine Tests** (as per QA table) | | |

# L.T. CONTROL CABLES

## LT CONTROL CABLES

**1.00.00 CODES & STANDARDS**

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

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

**2.00.00 TECHNICAL REQUIREMENTS**

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

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

2.03.00 Conductor of control cables shall be made of multi stranded, plain annealed copper.

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

2.05.00 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.

2.06.00 For multicore armoured cables, the armouring shall be of galvanised steel as follows :-

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

The gap between armour wire / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface.

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

(a) Oxygen index of min. 29 (As per IS:10810 (part-58))

(b) Acid gas emission of max. 20% (As per IEC-754-I).

(c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.

2.08.00 Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue and Black

5 core - Red, Yellow, Blue, Black and Grey

2.09.00 For cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed under neath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecuture numbers shall not exceed 50 mm.

2.10.00 In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath :

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

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

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

The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible.

2.11.00 All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part -3.

2.12.00 Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets.

2.13.00 In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

2.14.00 **Cable selection & sizing**

2.14.01 LT Control cables shall be sized based on the following considerations:

(a) Rated current of the equipment

(b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage

(c) Short circuit withstand capability

This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.

(d) The minimum size of conductor shall be 1.5 sqmm

2.14.02 Derating Factors

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

a) Variation in ambient temperature for cables laid in air

b) Grouping of cables

c) Variation in ground temperature and soil resistivity for buried cables.

2.14.03 Cable lengths shall be considered in such a way that straight through cable joints are avoided.

2.14.04 Cables shall be armoured type if laid in switchyard area or directly buried.

**3.00.00** **CONSTRUCTIONAL FEATURES**

3.01.00 **1.1 KV Grade Control Cables**

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

3.02.00 **Cable Drums**

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

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

(c.) The standard drum length for control cables shall not be less than 1000 metres. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drums with shorter lengths. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/- 2%.

**4.00.00** **TESTS**

4.01.00 **GENERAL**

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

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s)

are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

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

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

4.02.00 **TYPE TESTS:**

4.02.01 The Type tests reports for the following shall be submitted for one size of LT control cable :

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

10. Tensile strength and elongation test before ageing and after ageing

11. Ageing in air oven

12. Loss of mass test — For PVC insulation and sheath only

13. Hot deformation test — For PVC insulation and sheath only

14. Heat shock test — For PVC insulation and sheath only

15. Shrinkage test

16. Thermal stability test — For PVC insulation and sheath only

17. Oxygen index test — For outer sheath only

18. Smoke density test — For outer sheath only

19. Acid gas generation test — For outer sheath only

d) **For completed cables**

20. Insulation resistance test (Volume resistivity method)

21. High voltage test

22. Flammability test as per IEC - 332 Part-3 (Category-B)

4.02.02 **Acceptance Tests** (as per QA table)

4.03.00 **Routine Tests** (as per QA table)

# INSTRUMENTATION AND POWER SUPPLY CABLES

## INSTRUMENTATION AND POWER SUPPLY CABLE

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

1.01.00 **General Requirements**

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

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

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

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

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

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

**2.00.00** **Specification of Instrumentation cable**

2.01.00 Common Requirements

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

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

2.02.00 Specific Requirements

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

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

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

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

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

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

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

multi mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.

3.02.00 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum& crush resistance 4000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C

*3.03.00* All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.

3.04.00 Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables.

3.05.00 Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation.

3.06.00 Spliced / Repaired cables are not acceptable.

3.07.00 Penetration of water resistance and impact resistance shall be as per IEC standard.

**4.00.00 SPCIFICATION OF POWER SUPPLY CABLES**

Refer relevant subsections of this specification.

**5.00.00 INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY**

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the given Table A.

TABLE A: CABLE TERMINATION TO BE FOLLOWED

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

| | | | | |
|---|---|---|---|---|
| Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR | Group JB | Cage clamp (Rail mount) type. | Cage clamp (Rail mount) type. | F,G |
| Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR | Marshalling Cubicle/ Marshalling cum Termination Cabinet | Cage clamp (Rail mount) type. | Posts mount cage clamp type. | F,G |
| Marshalling cubicle/ Termination Cabinet | Electronic system cabinet | Cage clamp Post mounted type. | Plug in connector/Other System as per manufacturer's Standard | Internal wiring |
| Marshalling/ Termination System Cabinets | UCD mounted equipments | Post mount cage clamp type. | Plug in connector/Cage clamp type (rail mounted). | F,G (with plug-in connector at one end) |
| DDCMIS/PLC cabinets | PC, Printers etc. | Plug in connector | Plug in connector | Mfr.'s Standard |

Notes

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs except for pre-fabricated cables which shall be as per manufacturer's standard.
2. For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
3. Also refer Drg. 0000-110-POI-A-021.
4. *For high temperature applications only.
5. Instrument Cabling for instruments/equipments covered under subsection MAIN EQP INST SYS shall be as per manufacturer's standard .

| | |
|---|---|
| **6.00.00** | **TERMINAL BLOCKS** |
| 6.01.00 | All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The terminal blocks for DDCMIS input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT & VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Employer's approval. |
| 6.02.00 | All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc. |
| 6.03.00 | The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks. |
| 6.04.00 | For terminating each process actuated switches, drive actuators, control valves, Thermocouple, RTD, etc. in Local Junction Boxes, etc, refer Drg no. 0000-999-POI-A-065. |
| 6.05.00 | The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls. |
| 6.06.00 | For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to Employer's approval without any cost repercussions. |
| 6.07.00 | Internal wiring in factory pre-wired electronic equipment cabinets may be installed according to the Bidder's standard as to wire size and method of termination or internal equipment. Terminal blocks for connection of external circuits into factory prewired electronic equipment cabinets shall meet all the requirements as specified above. |