

EPC execution of Power House Electro-Mechanical Works of Heo Hydro Electric Project (240MW) Arunachal Pradesh		Particular Technical Specifications
		Volume II Section-I
		General Tech. Specification

VOLUME II:

Section-I

General Technical Specifications

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0 GENERAL INFORMATION

0.1 General

The Contractor shall strictly observe this General Technical Specification in conjunction with the Particular Technical Specifications. The contractor shall carry out all work in a skilled and workmanlike manner in compliance with modern methods of engineering. All design, calculations, materials, plant, manufacture and testing shall conform to the latest applicable standards.

In addition, the Contractor shall conform to all applicable regulations regarding the execution of construction and installation work, and shall follow all instructions issued by the competent Authorities and the Engineer-in-Charge of the Corporation.

The Particular Technical Specifications shall take precedence over the General Technical Specifications in case of any contradiction.

Clause number cross-references refer to the volume in which they occur unless stated otherwise.

0.2 Scope of Work

The scope of work in this Contract covered by the Electrical and Mechanical works, General Technical Specification is broadly established in the Particular Technical Specifications (Volume-II, Section-II). In addition to this the Contractor shall prepare the detailed design and engineering, manufacture, testing at works, despatch and delivery of all electro-mechanical equipment to be installed in the power house of 3 x 80 MW Heo Hydro Electric Project and covered in this General Technical Specification (Volume II, Section I), Schedule of Requirement (Volume-II, Section III) and drawings (Volume -II, Section IV) including construction and installation drawings as well as calculations, material specifications, operating and maintenance instructions, etc., as detailed in the Particular Technical Specifications.

The scope shall also include:

- Overseas transportation covering freight and insurance from port of shipment to the port of entry of India and customs clearance and port charges etc. (in case of goods of foreign origin) if applicable,
- Inland transportation in India including freight and insurance for delivery at project site,
- Storage and preservation of all equipment at site or any other intermediate locations till installation and commissioning,

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- Complete assembly, erection, testing and commissioning at site,
- Design and Engineering on Computerised Modelling System including supply and installation of software and hardware of international repute for completed plant documentation,
- Training of purchaser's personnel in Design, Engineering, operation and maintenance of plant,
- All other works incidental to and connected to the above services from delivery up to the handing over the equipment after successful commissioning.

Any item though not specifically mentioned above but needed to complete the system and equipment to meet the intent of specification shall be deemed to be included in scope unless otherwise brought out under exclusions.

The Contractor shall manufacture, supply, install, test and commission the plant complete in every respect with the necessary accessories for reliable continuous operation, even if not all details are explicitly mentioned in the Specifications.

These Specifications include the performance of all work and the provision of all materials, permanent and temporary equipment, tools, accessories for transport to the site, including loading, unloading, if necessary reloading in the port of arrival, intermediate storage, protection of the plant from the effects of the weather, cleaning, drying, complete installation, painting, testing and commissioning of all plant and its accessories.

The Contractor shall make competent and experienced staff available for the training and assistance of the operating staff during commissioning and Test Service Period operation and, if required by the Corporation, for a period after completion of the Test Service Period which shall be agreed separately.

Exclusions :

The following item/ services shall be excluded from present scope of works :

- Civil works as detailed in clause no. 10 of this specification,
- 220kV Transmission lines.

The above works as excluded from the present scope shall be undertaken by the purchaser through separate contract.

0.3 Standards

Although Indian or IEC standards for workmanship material and plant have been selected generally in these specifications as a basis of reference, other standards

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and recommendations of standard international organisations will be acceptable provided they ensure equal or higher quality than those specified, and provided, furthermore, that the Contractor submits for approval, detailed standards which he proposes to use.

Except where modified by this specification, plant and materials shall be in accordance with BIS (Bureau of Indian Standards), IEC (International Electro technical Commission) and ISO (International Organisations for Standardisation) Standards. If relevant BIS, IEC and ISO Standards are not available in any case or cases then relevant International Standards shall be proposed by the Contractor for approval by the Engineer.

When BIS, IEC or ISO Recommendations or International Standards are referred to, the Edition shall be the latest at the time of Contract signature, together with any Amendments issued up to date. A list of national standards not complying with IEC standards to be used shall be given by the Contractor of the plant.

If requested by the Engineer the Contractor shall supply at his own expense three copies in English and one in the original language of any standards that are applicable to the Contract.

0.3.1 Standards for General Application

Standard publications issued by the following organisations of standardisation are considered being approved standards for the works:

- BIS Bureau of Indian Standards
- ISO International Organisation for Standardisation
- IEC International Electrotechnical Commission
- DIN Deutsches Institut für Normung
- VDC German Electromechanical Commission
- VDE Verein Deutscher Elektrotechniker
- VDI Verein Deutscher Ingenieure
- JIS Japanese Industrial Standards
- BSI British Standards Institution
- ASTM American Society for Testing Materials
- ANSI American National Standard Institute
- ASME The American Society of Mechanical Engineers
- IEEE The Institute of Electrical and Electronics Engineers Inc.
- NEMA National Electrical Manufacturers Association
- SIS Swedish Standard Institution

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0.3.2 Basic Design Standards

ISO System for Limits and Fits	ISO/R286 - 1963
General Tolerances and Deviations	ISO/R1829 - 1975
Permissible Machining Variations in Dimensions Without Tolerance Indication	ISO/2786 - 1773
Screw Threads	ISO 68 - 1973 ISO 262 - 1973 ISO/R724 - 1978
General Principles for the Verification of the safety of Structures	ISO 2394 - 1973

0.3.3 Manufacturing and Testing Standards

Methods and Definitions for Mechanical Testing of Steel Products	ASTM-A370
Tension Testing of Metallic Materials	ISO/R82 - 1959
Notched Bar Impact Testing of Metallic Materials	ISO/R83 - 1976 ASTM-E23
Bend Test for Steel	ISO/R85 - 1959
Liquid Penetrant Inspection	ASTM-E165
Recommended Practice for Radiographic Testing	ASTM-E94
Ultrasonic Examination of Heavy Steel Foreigns	ASTM-A388
Guided Bend Test for Ductility of Welds	ASTM-E190
Welders' Qualifications Test	AWS (American Welding Society) Group B, DIN 8560, DIN 4100
Preparation of Steel Surfaces for Painting by Sandblasting	SIS 05-5900
Designation of Degree of Rusting of Painted Surfaces	DIN 53210
Certificates of Material Testing	DIN 50049

0.3.4 Material Standards

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ASTM (American Society for Testing Materials), DIN (German Institute for Standards) and BSI (British Standards) are approved standards for the supply of materials. The applicable ASTM standards are listed below. Metric standards designated with “M” shall have priority for actual applications.

Material	Standard	Quality
Gray cast iron	ASTM A 48	Class 35,30
Ductile cast iron	ASTM A 536	Grade 60-40-18
Cast carbon steel	ASTM A 27 M ASTM A 216 M	Grade 450-250, 485-250 or 485-275
Cast alloy steel	ASTM A 148 M	Grade 550-275
Corrosion resistant cast steel	ASTM A 351 M ASTM A 487 M ASTM A 743 M ASTM A 744 M	CA 6 NM Grade CA -15, CF-8
Forged steel for gears	ASTM A 291	Class I
Cold finished for shafts	ASTM A 108	Grade 1022
Forged steel for shafts, trunnions etc.	ASTM A 668 M	Class C & D
Wrought steel wheels and sheaves	ASTM A 504	Class A
Forged alloy steel for general use	ASTM A 182 M, A 336M, A 508 M or A 541M	
Steel plated for principle stress carrying parts	ASTM A 36 M ASTM A 283 M ASTM A 570 M ASTM A 573 M ASTM A 678 M	
Steel plates for high stress	ASTM A 225 M ASTM A 516 M ASTM A 517 M ASTM A 537 M ASTM A 543 M	Grade D Grade 415,450,485 Grade F Class 1 Class 3

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Steel plates for pressure vessels	ASTM A 285 M ASTM A 516 M	Firebox quality Gr.B
Alloy steel for springs	ASTM A 689	
Corrosion resistant steel plates	ASTM A 167 ASTM A 176	Type 304 Type 403
Steel bolts and nuts	ASTM A 193 M ASTM A 194 M	Grade B7 Grade 2H
Corrosion resistant forged steel for sections, bolts & nuts	ASTM A 276	Type 304,410,420
Welding rods for corrosion resistant steel and carbon steel	AWS D1.1	
Steel piping	ASTM A 53	Type S or E
Pipe fitting	ASTM A181 M	Class 70
Galvanising for steel piping section and plates bolts and nuts	ASTM A 53 ASTM A 123 ASTM A 153	
Cast bronze	ASTM B 505 ASTM B 584	Alloy C86700 or C93700
Base metal for self-lubricated bearings and bushes	ASTM B 22 ASTM B 584	Alloy C90500 or C86300 Alloy C86200
Bronze for bearing,bushes thrust shoes etc.,	ASTM G 13584	Alloy C93200 or C93700
White metal for bearings	ASTM B 23	Alloy No. 3
Bronze for gears	ASTM B 148	Alloy C95500
Brass for bolts and nuts	ASTM B 21 M	Alloy C48500
Copper piping	ASTM B 42	C10200
Copper tubing for grease lubric.	ASTM B 751	
Copper alloy tube for heat exchangers	ASTM B 111M	Alloy C68700

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Chromium electroplating for pins	ASTM B 177	Condition A or B
Electrolytic copper for conductors		Minimum purity 99.9 %
Gasket for pipe and fitting	ASTM A 564 M	

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and the classifications and grades in conformance with the latest issue of the respective ASTM, DIN standards. Material to other standards may be used if approval by the Engineer has been obtained. Material specifications including grade or class data shall be shown on the appropriate detail drawings submitted for review.

If using stock material not specifically prepared for the works under this Contract, the Contractor shall submit evidence that the material complies with approved standards and that the material is adequate for the intended use.

The Contractor shall indicate in the Technical Data Schedules, the materials and applicable standards for all major parts of the supply.

The materials shall be carefully selected for the intended purpose and due consideration of the site conditions and the tropical environment. Higher grade material shall be used where ordinary material is insufficient.

0.3.5 Electrical Standards

The following basic standards for electrical works or any other approved standard shall be considered:

- Diagrams, Charts, Tables, IEC Publication No. 117 (preparation of diagram and tables, etc.)
- Standards issued by CCITT (International Telephone and Telegraph Consultative Committee).

For specific standards see the Particular Technical Specification.

0.3.6 All plants, equipment, materials, workmanship, inspection and testing etc. covered under this package shall have to follow relevant Indian Standard and any Indian Statutory requirement wherever applicable.

0.4 Design Improvements

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The Corporation 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.

The Contractor should however, note that changes proposed by him will have to be supported with applicable type test reports or any documents considered essential in this regards.

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 change in 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.

0.5 Quality Assurance Programme

To ensure that the equipment and / or services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the work site of the Corporation or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted and approved by the Corporation after discussions before finalisation of the Contract. A quality assurance programme of the Contractor shall generally cover the following:

- a) His organizational structure for the management and implementation of the proposed quality assurance programme
- b) Documentation control system
- c) Qualification data for Contractor's key personnel
- d) The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control
- f) List of all tests / checks to be carried out during manufacturing shop assembly / site tests / pre-commissioning checks etc. List shall be detailed so as to identify the tests/ checks to be witnessed by the Corporation.
- g) To identify the list of subcontractor.

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- h) A detail PERT network showing the various activities such as design, manufacture, shop testing, transportation loading, un-loading and reloading as may be required before & after transportation.
- i) Control of non-conforming items and system for corrective actions
- j) Inspection and test procedure both for manufacture and field activities
- k) Control of calibration and testing of measuring and field activities
- l) System for indication and appraisal of inspection status
- m) System for quality audits
- n) System for authorizing release of manufactured product to the Corporation
- o) System for maintenance of records
- p) System for handling storage and delivery
- q) A Quality Assurance Plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment finished and or services rendered.

0.5.1 Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents at the time of dispatch of the Equipment.

- a) All Non-Destructive Test procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports
- b) Welder qualification certificates (Boiler quality)
- c) Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols
- d) Raw Material test report as specified by the specification and or agreed to in the Quality Assurance Plan
- e) The Quality Plan with verification of various customer inspection points, as mutually agreed and methods used to verify that the inspection and testing points in the Quality Plan were performed satisfactorily
- f) Stress relief time temperature charts/oil impregnation time temperature charts

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- g) Factory test results for testing required as per applicable standards referred in the specifications.

0.6 Design Co-ordination

The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly, dis-assy. and maintenance.

The Contractor has to coordinate designs and terminations with the corporation as well as their Consultants. The names of agencies shall be intimated to the successful Bidders.

0.7 Design Co-ordination Meeting

The Contractor will be called upon to attend design co-ordination meetings with the Corporation and their Consultants during the currency of the Contract. The Contractor shall attend such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

0.8 Units of Measurements

The International System (SI) of measures and weights shall be used for documents, correspondence, drawings etc., relevant to the Tender and the subsequent Contract.

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0.9 Plant Identification System

An uniform plant identification system shall be applied for all mechanical, electrical and Instrumentation and Control (I&C) systems and installations and shall be submitted for approval by the Corporation before commencement of the respective activities.

0.10 Programme of Work

According to the relevant articles in the 'Condition of Contract' (Vol.I, section III) the progress of the work shall conform to the basic Programme of Work on which the Contract is based.

The detailed programme / schedule of work shall be submitted in accordance with the Contract Conditions, and shall include the following information ;

- Design work
- Procurement
- Shop work and testing
- Transportation to the Site
- Loading & un-loading
- Intermediate storage
- Storage and handling at site
- Erection, testing and commissioning
- Trail run operation
- Performance guarantees test
- Removal of erection equipment and clearing of Site
- Interdependence with work of other contractors.

The Contractor shall pay particular attention to the dates established for the submission of “installation and foundation” drawings with loading data, anchoring details, recesses, block-outs etc., and all information necessary for the preparation of the civil work design drawings.

Since the Schedule dates are dependent on the progress of other contracts, the Contractor shall suitably co-ordinate his operations at the Site with those of other contractors.

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0.11 Tenderer shall have to furnish list of sub-contractor.

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1 TECHNICAL DOCUMENTS

1.1 General

Contractor shall have to consider the Corporation's drawings furnished in Vol.II, Section IV for their planning.

Contractor shall have to furnish their detail list of drawings / documents / catalogues / published papers etc. showing the schedule of submission.

This Chapter specifies the general scope and gives a definition of the documents which, together with those listed in the Particular Technical Specifications, shall be delivered by the Contractor to the Engineer within the periods, and in a number and quality as specified in the General Technical Conditions.

The Engineer reserves the right to request the Contractor for additional documents as may be required for proper understanding and definition of constructional, operational, co-ordination or other matters.

The Contractor shall co-operate with other Contractors in the exchange of drawings, dimensions, data and all other information required to ensure proper co-ordination of the work. All documents to be supplied shall be submitted in accordance with the agreed programme so that any comment and change requested by the Engineer can be taken into account before starting of the manufacture in the workshop and / or erection or installation at the Site.

If the Contractor fails to submit such documents, then later on execution of changes requested by the Engineer and the resulting additional cost and/or delays shall be the Contractor's responsibility. The Contractor shall not be relieved of his responsibility and guarantee after drawing and computations have been approved by the Engineer.

The preparation of drawings, computations or other technical documents shall not be sublet by the Contractor without the written authorization of the Engineer. In such a case the Contractor shall be fully responsible for such drawings, computations and other technical documents as if they were done by himself.

On drawings, catalogue sheets or pamphlets of standard plant submitted to the Engineer the applicable types, paragraphs, data etc., shall either be marked distinctively or the non-applicable parts shall be crossed out. Documents not marked in such a manner will not be accepted and approved by the Engineer.

If required for proper understanding of the documents, additional descriptions / explanations shall be given on these documents or on separate sheets. All symbols, marks, abbreviations, etc., appearing on any document shall clearly be explained by a legend on the same document or on an attached sheet.

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Each device appearing on any document (drawing, diagram, list, etc.) shall clearly be designated. The abbreviation mark used for an individual device shall be identical throughout the complete documentation so as to avoid confusions. All documents shall have a uniform title-block as outlined in the 'Conditions of Contract' and agreed by the Engineer. Beginning with the very first submittal to the Engineer, the Contractor's drawings shall bear serial number corresponding to a drawing classification plan to be agreed upon by the Contractor and the Engineer.

Revised technical documents replacing previously submitted documents shall be marked accordingly. Also, the revised part in the Document itself shall be marked clearly. Volume II, Section I Annexures of this Volume specifies the documents to be supplied and the required status, namely "FOR APPROVAL" (A) or "FOR INFORMATION" (I), respectively.

Any comment given by the Engineer on an "I" type drawing shall have the same effect as if it were given on an "A" type drawing.

1.2 Drawings

1.2.1 Loading Drawings

For all larger pieces of plant which, due to their dimensions and / or weight subject to transport limitations will require special means for their transportation the Contractor shall submit binding loading drawings indicating dimensions, weights, etc., of the respective pieces of plant and the necessary details of trailer for its transportation to the site.

1.2.2 Foundation Drawings

If a piece of plant requires its own foundation or needs a special area for installation, the Contractor shall submit drawings indicating all pertinent dimensions, static and dynamic loads, etc. They shall include all essential details required for proper design and construction of the foundations and/or buildings. Detail drawings of all embedded parts shall be submitted.

In addition, they shall include openings, sleeves, slopes and arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purpose.

If conduits are to be installed in the foundations, the relevant information such as diameter, length, and purpose shall be indicated on the drawings.

1.2.3 Arrangement Drawings

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All arrangement drawings shall be drawn to scale. The General Arrangement Drawings shall show the physical arrangement of plant (machines, complete switchgears, control panels, instrument cubicles, etc.) civil constructions (buildings, rooms, foundations, ducts, etc.) and reserved areas (for pipes, cables, lines, etc.) in relation to each other and to agreed co-ordinates and boundaries. Such drawings shall be prepared for the whole plot, for separate plots and for each building (building, hall, room, ducts and trenches, etc.).

The Arrangement or Layout Drawings of electrical, instrumentation and control equipment shall indicate the location of all apparatus wherever used, i.e. in or on machines, control boards, switchboards, cubicles, control desks and panels, etc. The apparatus shall be denominated with the same standardised abbreviations as used in all other document.

1.2.4 Outline Drawings

The Outline Drawings shall show all elements and the main dimensions of individual components where necessary in plan view, cross-section, side and top views. If reasonably possible such dimensions can be shown on Arrangement Drawings.

1.2.5 Design Drawings

The Design Drawings shall include the shop drawings, assembly, drawings, erection drawings, piping diagrams and piping arrangement drawings, etc., showing the dimensions, design and data of all apparatus and plant to be furnished under this Contract.

The drawings shall – where applicable – substantially conform to the Tender Drawings and shall show:

- details of manufacturing and treatment of major single work pieces specially manufactured for this Contract
- assembly of the plant in plan and elevation with main dimensions
- sub-assembly of the principal components of the plant with overall dimensions, adjustment and clearance tolerances, and numbers of corresponding detail drawings
- sub-assemblies in which the Contractor proposes to ship the plant
- all necessary details of the parts connecting to plant supplied by others
- location and sizes of auxiliary connections for oil, grease, water, air, etc.
- location and size of the instruments and accessories provided

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- method of lubrication and sealing
- instructions for heat treatment, pressure tests, surface preparation and anticorrosive protection
- full details of parts for which adjustment is provided or which are subject to wear
- method and sequence of installation, field joints, erection and lifting devices, jacks, grout plugs, anchoring details, etc., if not shown on foundation drawings.

1.2.6 Installation Drawings

The mechanical, electrical and I & C Installation Drawings shall provide detailed information on the disposition of the various items of a system (e.g. lighting fixtures, socket outlets, connection boxes, transmitters, actuators, loudspeakers, telephones, pipes, valves, pumps, compressors, etc.) and of the piping and wiring respectively included in the installation or assembly. They shall be based on dimension drawings of cubicles, rooms, buildings, or areas containing the plant.

1.3 Diagrams


For electrical diagrams general reference is made to IEC 113-1.

1.3.1 Single Line Diagrams (SLD)

This is a simplified diagram of the essential electrical plant and their interconnections. Each circuit shall be represented by a single line only. It shall contain all required technical information of the plant represented, e.g. voltage, ampacity, capacity, short-circuit level, ratios, voltage variations, positive and zero sequence impedances, measuring transformer and protection relay, indicating devices, interlocking, kind of switch drive, code designation etc.

Single-line diagrams of individual main components and switchboards shall additionally show the control, indicating, measuring, metering, protection automatic, and other auxiliary electric devices separate for each individual installation site and location as applicable:

Local	Switchyard/GIS control compartment, switch compartment, cable termination compartment, etc.
Remote	Control room (in control panel, control desk)
	Unit control panel
	Relay room (in auxiliary relay cubicle, marshalling rack, automatic control cubicle, protection cubicle)

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		Separate energy meter cubicle. Furthermore, the applied recommended setting of adjustable devices (protection and control elements, time relays, etc.) shall be indicated

1.3.2 Circuit Diagrams

The Circuit Diagrams shall show the power circuits in all phases with the main apparatus as well as the pilot circuits (measuring and control circuits). It shall show in full the functioning of part or all installations, plant or circuits with all required technical information.

The control part shall be subdivided into separately drawn “current paths”, each showing all its components regardless of their actual physical location. The individual circuits are to be drawn in a straight line sequence, avoiding line crossings. The current paths (to be designated by numbers) shall be drawn starting from two horizontal lines which represent the control voltage source. All devices belonging to the plant or forming part of the plant or control devices shall appear between these two lines.

Contract developments of the installed switches, contactors, relays and other apparatus which appear in the diagram shall be shown below the respective contactor coil, indicating by means of numbers and, if not on the same, also the page No., the current path in which the corresponding contact has been used.

Interconnections to other circuit diagrams shall be clearly marked by means of dotted line separations and the corresponding functional designation.

The power circuit portion of the installation shall be drawn at the left side of the drawing.

Circuit diagrams shall also contain all terminals and their correct designations. Terminals grouped together to terminal blocks of switchboards, distributors, etc., shall be shown on the circuit diagrams in one fictitious horizontal line surrounded by demarcation lines. If, for any reason, the current paths of circuit diagrams must be separated, the corresponding counter terminal has to be indicated by all means.

The representation of electrical plant and control circuits shall not be terminated at the limits of the scope of supply, but has to be extended beyond this limit by all switchgear, protective, measuring and monitoring equipment required for full comprehension of the whole circuit. All terminals and functions of plant to be supplied by others shall be taken over as well.

Standard Circuit Diagrams are patterns of circuit diagrams which have been standardized with regard to scope, arrangement, representation and allocation of plant with the aim of simplification and easy surveillance of electrical circuitry.

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1.3.3 Connection Diagrams

The internal Connection or Wiring Diagrams shall show the wiring or tubing connections either within one apparatus or between several apparatuses of one group. They shall contain the single components or apparatuses of one group arranged in the correct physical location including terminals and terminal boards. The connections shall either be represented by lines or, in case of a “wireless” connection diagram by a wire table.

The external Connection or Interconnection Diagram shall show the external wiring or tubing connections between the different units of an installation.

1.3.4 Block Diagrams

The Block Diagrams shall be used to show in a simplified manner the main inter-relationships between the elements of a system by means of symbols, block symbols and pictures without necessarily showing all the connections. The symbols used for the individual kinds of components, e.g. servo-motors, amplifiers, computing modules, etc., shall clearly be explained on the diagram or on an attached legend.

When recommendable, a Block Text Diagram may be prepared, consisting essentially of explanatory texts enclosed in outlines which are linked by lines showing the functional relationships that exist between the various parts of an installation, plant or circuit.

1.3.5 Logic Diagrams

The Logic or Functional Diagrams shall be used for representation of logic and sequence controls and interlockings by showing only binary elements and their effect on the various process equipment disregarding their electrical realization. Logic function elements (AND, OR, NOR, NAND, STORAGE, etc.) shall be used for processing and combining binary signals.

1.3.6 Process or P & I Diagrams (P&ID)

The Process or P&I Diagrams shall show the piping including type, dimensions, fittings, flanges, etc., and the flow directions. They shall also show the process data, measuring points, instrumentation, control functions and locations of the plant. All P&I Diagrams shall comply with the requirements of ISO – Standards 3511 (process measurement control functions and instrumentation-symbolic representation).

1.3.7 Terminal Diagrams

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Such diagrams shall be prepared for any type of terminal box, marshalling rack, control cubicle, switchboard, etc., and shall show the terminals (properly numbered) and the internal and/or external conductors (wires or cables) connected to them.

The terminal diagram of each individual switchboard, terminal box, panel, etc., shall contain, but not be limited to the following information:

- terminal number of terminal board with targets (terminal number and current path) of incoming and outgoing cables and wires
- cable designation
- type of cable
- number and cross-section of conductors
- assignment of conductors
- number of spare conductors
- approx. length of cable and its destination.

1.3.8 Protection Co-ordination Diagrams

These diagrams shall show in a graphical manner separately for each power supply circuit:

- a simplified single-line diagram of the circuit with technical data of all instrument transformers and relays
- co-ordinated tripping curves of related protection devices
- setting of the protection devices.

1.4 Specifications

1.4.1 Material or Plant Specifications

Specifications shall be prepared for all principal plant and installations. They shall describe the performance (design, material, dimensions etc.) of the plant and include a list of components providing information on the manufacturer, type and technical data to obtain the following:

- full information on the plant, completing the general requirements fixed in the Tender Specification by the data / information of the specific manufacture
- proof of compliance with Contract Specification.

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For standard plant catalogues or pamphlets can be submitted as described under Clause 1.1.

1.5 Lists and Schedule

1.5.1 List of pipes, valves, fittings etc.

This list shall include all the main pipes, valves & fittings etc. required for different purposes covered under this Package and shall contain at least the following information/data.

- Plant identification number
- Description
- Name of manufacturer & type
- Size & material
- Nominal pressure

1.5.2 List of pumps, strainers & filters etc.

This list shall be prepared according to the requirement of the plant the details of pumps, strainers & filters covered under this contract.

- Plant identification number
- Description
- Name of the manufacturer & type
- Dimension / weight of complete pump (with motor)
- Dynamic head
- Speed of pump
- Discharge m³/sec.
- Shut off head of pump
- No. of pump impeller / material of impeller.

1.5.3 List of motors, heater, motor operated valves

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The lists shall be prepared according to the switchgears and distribution boards, the consumers (motors, heaters, motor operated valves, etc.) are connected to, and shall contain at least the following information / data:

- plant identification number
- description
- manufacturer, type, rated data of driven machine
- rated capacity
- service factor (ratio between motor output and power requirement of the driven machine)
- rated speed
- rated voltage
- rated current
- ratio of starting current to rated current
- ratio of pull-out torque to rated torque
- power factor at rated capacity
- efficiency at rated capacity
- power consumption at machine design loading
- total weight
- design/enclosure/cooling (acc. to IEC)
- duty (continuous/intermittent/start-up)
- starting method/permissible starting frequency
- denomination of feeder
- protection
- applicable Standard Circuit Diagram (Category)
- maximum number and overall diameter of power cable(s)
- manufacturer and type of bearing(s)

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- manufacturer, type and quantity of lubricant, service interval
- manufacturer, type, number, size, spring pressure and service interval of brushes.

1.5.4 Motor Starter Lists

The motor starter lists shall include all starters and contactors used for motors and contain the following technical information as a minimum:

- plant identification number
- electrical design data as nominal and actual current rating, voltage rating, coil rating, making and breaking capacity, mode of operation
- maximum power cable size
- maximum control cable size
- current transformer ratio, class and capacity
- type of protection relaying and catalogue number
- setting of protection relays and maximum continuous rating of the protected circuit
- type and current rating of the back-up fuses / MCCB's for the main and MCB's for control circuits.

Note: Motor Starter Lists can be substituted by adequate plant lists, already forming part of switchgear manuals.

1.5.5 Cable Lists

The Cables Lists shall include for each individual cable the following as a minimum:

- cable number, in accordance with Identification System
- cable type
- No. of cores
- Material of conductor
- Continuous current rating in air
- rated voltage

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- number and size of conductors
- overall diameter
- cable termination at each end
- connection point at each end with cubicle / plant identification and terminal numbers
- cable routing.

1.5.6 List of Measurements

This list shall indicate all measurements, local as well as remote, and shall contain at least:

- item / code number, function code
- description and denomination of measuring loop
- data of tapping point
- data of local devices (as detectors, instrument transformers, transmitters)
- data of remote devices
- accuracy class
- digital / analogue

1.5.7 Alarm Lists

These lists shall indicate all alarms and shall contain at least:

- item / code number, function code
- description and denomination of alarm
- data of alarm detector (contact)
- data of alarm annunciator (location and clear text labelling) collection of group alarms.

1.5.8 List of Final Control Elements

This list shall indicate all control actuators and control valves and shall contain at least:

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- item / code number
- data of pipe and valve connections
- data of valve layout
- maximum required and rated power.

1.5.9 Workshop Test Schedules

Individual Workshop Test Schedules shall be prepared for plant / installations (such as machines, switchgears, control gear, cables) and shall contain at least:

- plant identification number and name
- manufacturer
- place of manufacture
- place of test
- date of test
- objective of test (all individual tests)
- standards applied
- certification
- inspection (by Engineer / Independent Test Authority / Contractor / Subcontractor)
- release for shipment
- remarks.

On the above schedule or on separate sheets the Test Procedure shall be specified giving for each test item (kind of test) a description, test method / Standards, used instruments, type / routine test / acceptance test / test judgment.

1.5.10 Site Test Schedules

Scope as in 1.5.9 above - as applicable.

1.5.11 List of Tools and Appliances

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List of Tools and Appliances shall detail for all tools and appliances included in the scope of supply:

- item and code number
- description
- quantity
- weight
- gross storage requirements (separate for open-air, indoor, air conditioned) for individual component sets.

1.5.12 Spare Part Lists

Spare part lists shall detail for all parts included in the scope of supply:

- item and code number
- description
- quantity
- weight
- gross storage requirements

1.5.13 List of Consumables

List of Consumables shall include the following

- item and code number
- description
- quantity
- weight
- gross storage requirements (separate for open-air, indoor, air conditioned) for individual component sets.

1.5.14 List of Plant Identification Numbers

This list shall contain the used plant identification numbers in alphanumeric order and for each of them a description (the defined plant denomination, for example as written on the plant label) and the location (short definition of outdoor area and level elevation or building / room with elevation and room number).

1.6 Calculations

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In addition to the drawings or whenever the contractual documents do so require, the Contractor shall submit to the Engineer for checking, the appropriate calculations for determining the main sizes, dimensions and operational characteristics, clearly indicating the principles on which the calculations were based. The calculations shall include the formulas, standards, test results, basic assumptions, etc. Submission of the calculation without baseline information will not be accepted.

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1.6.1 Short-Circuit Calculations

The short-circuit calculations shall be performed in accordance with relevant Indian Standards or VDE Standard 0102, Part 1 or IEC 909

Wherever applicable, the following maximum values for plant layout and maximum and minimum values for protection system layout shall be calculated for the individual plant components:

- Initial symmetrical short-circuit capacity $S''_{k(3)}$ and current $J''_{k(3)}$
- Symmetrical breaking capacity $S_A(3)$ and current $J_A(3)$
- Peak asymmetrical short-circuit current $J_S(3)$
- Sustained short-circuit current $J_k(\text{rms})$ (3)

Moreover, the following values shall be calculated for solidly or partially earthed network systems:

- maximum single-pole short-circuit $J''_{k(1)}$
- maximum earth fault current J_E as determined by the earthing resistance R_E
- maximum contact voltage as determined by the values as stated above.

1.6.2 Voltage Drop Calculations

The voltage drop calculations shall be determined for different networks / feeders of the complete electrical system.

1.6.3 Earthing Network Calculations

The Earthing Network Calculation shall determine on basis of the short-circuit currents the relevant design criteria for the layout of the plant's Earthing Network and the potential gradient control system, such as:

- earthing resistance
- earth electrodes or conductors(number and dimensions)
- mesh network and other means for potential gradient control for different locations (mesh widths and dimensioning)
- maximum contact, step voltages & transferred voltages

1.6.4 Generator Earthing System Calculation

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This calculation shall prove the correct selection of the generator earthing equipment.

1.6.5 Load Evaluations

The load evaluations shall demonstrate for each voltage (AC and DC), and for each individual distribution board / MCC, the following data:

- rated capacity of all consumers
- maximum number of identical consumers which can operate simultaneously
- total electric demand in kVA and the power factor at nominal service of the driven machine, subdivided into
 - start-up
 - rated service
 - shut-down
 - stand-still

The maximum load on one of the MV or LV auxiliary supply transformers shall be determined with due consideration of the most unfavourable condition when feeding, specially in case of emergency, several main and sub-distribution boards.

1.6.6 Selection of LV Breakers and Minimum Cable Cross Sections

This paper shall prove the correct application of LV breakers and - where required - of short circuit current limiting devices.

The minimum size of cable connections shall be calculated applying the max. admissible temperatures and ratings (continuous and short circuit conditions).

The results shall be shown in a table containing at least:

- the maximum initial symmetrical short circuit current before and behind the switchgear (breaker/fuse)
- the breaker setting range
- the let-through current
- the resulting minimum cable cross section
- the applicable standard cross section.

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Contractor's shall have to furnish all test certificates as given in the relevant parts of tender document.

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1.7 Operation and Maintenance Manuals

1.7.1 Contents

The Operation and Maintenance Manual shall be provided. All information necessary for the reliable operation and maintenance of the equipment shall be summarized in the form of an A4 size manual incorporating the documents described below:

<u>Volume</u>	<u>Title</u>
(I)	Operating Instructions
(II)	Part A - Mechanical Plant, Part B – Electrical Plant
(III)	Control, Metering and Protective Equipment
(IV)	Hoisting and Lifting Equipment
(V)	Domestic Installations

The above volumes shall be bound in covers with different colours, preferably blue, red, green and yellow for volumes (I) of (V).

Individual volumes shall contain at least the following documents and data:

Vol. (I)	<p>General description of the equipment, operation particulars</p> <p>Main technical characteristics</p> <p>Connection to external systems (electricity, water, etc.)</p> <p>Instructions for operating personnel including periodic tests, check-points, actions required following each individual alarm signal, etc.</p> <p>Summary of important rules, standards, safety precautions and instructions to be followed during equipment operation and maintenance</p> <p>Safety and warning signs to be placed on the equipment</p> <p>Important principle diagrams (piping, electrical services) and layout drawings</p> <p>Parts lists.</p>
Vol. (II)	<p>List of all Subcontractors and suppliers with addresses</p> <p>Standard documents (catalogues, etc.)</p> <p>Detailed data sheets with all technical characteristics necessary for operation, ordering or new parts and maintenance for motors, valves, etc.</p>

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Operation and maintenance instructions indicating the maintenance intervals, special safety precautions, special tools, description / sketches required for maintenance works, etc.

Lists of spares with identification codes and all information necessary for direct ordering from the manufacturers

Assembly drawings and important detail drawings

Copies of all test certificates for plant and equipment such as pressure vessels, safety valves, cranes, hoists, etc., in English. (Originals to be bound in book form and submit to Corporation after Taking Over Certificate (TOC)).

Vol. (III)

As in (II) above plus

All main single line diagrams, main layout and arrangement drawings

Cable lists of power cables and layout of cable ways

Circuit and wiring diagrams of power and control systems including terminal designation

Apparatus and equipment detailed diagrams and descriptions of function and maintenance requirements

Detailed functional diagrams for regulation, control, metering and protection systems, circuit diagrams of all printed circuit boards (PCB)

Detailed diagrams for remote control, signal transmission and communication systems

Cable list of control and metering cables

List of information / signals to be exchanged with other contractors.

Vol. (IV) and

Vol. (V)

Applicable documents as per above volumes (catalogue's data-sheets, illustrations)

Sections on "maintenance" shall be divided into two parts:

- Current (preventive) maintenance indicating inspection periods, routine clearing and lubricating procedures, safety checks, adjustments, etc.
- Repairs and overhauls describing the dismantling, removal and replacement of parts (with spare parts), trouble-shooting guides, repair instructions including heat treatment processes, welding procedures etc.

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1.7.2 Performance

The Engineer reserves the right to specify a uniform cover (loose leaf binder) for all operating and maintenance instructions prepared by the various contractors for individual lots. The Contractor shall not be entitled to claim extra payment for this requirement.

Furthermore, the Engineer may request the Contractor to adapt drawings (single line, wiring, terminal diagrams, etc.) to drawing of another contractor in order to facilitate maintenance, surveillance, repair of faults, etc. Each kind of drawing aforementioned, shall have a uniform size. The final size of drawings for the Operation and Maintenance and Manual shall be decided by the Engineer. Catalogue sheets, illustrations, printed specifications, etc., shall be checked and prepared by the Contractor in such a way that the figures, statements and data valid for the delivered sizes and types of the plant concerned are clearly marked. All figures, statements and data valid for sizes and types not delivered must be crossed out.

1.7.3 Revisions and Supplements

The completeness of the manuals shall be checked during installation, testing, commissioning and trial operation jointly by the Contractor and Engineer.

If it becomes evident during the installation, commissioning trial operation and defects liability period of the plant that the Operation and Maintenance Manuals are inadequate or incorrect, the Contractor shall supply immediately the necessary supplements and corrections. This shall be handled in the following manner:

Deletions

One sheet of errata, printed on pink paper, shall be issued indicating the pages and date of issue of those pages which are to be deleted and are no longer valid.

Corrections, Revisions, Replacements

New sheet or sheets shall be issued to replace the wrong pages. Whenever a new sheet is added to the instruction manuals, this sheet shall be given the new date of issue and a revision symbol, and an indication "Substituted for....." and a marking of the corrected / revised items.

Insertions, Supplements

Insertions or supplements shall be accompanied by a new respective "Table of Contents" page, where the latter shall be handled as described above under replacements.

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The revisions and supplements requested by the Engineer shall be made by the Contractor at the Site as far as possible and shall be submitted in each case to the Engineer for checking and revision as stated above.

Before issuing the "Taking-Over Certificate" the revised copies of the Operation and Maintenance Manual shall be submitted together with the specified number of complete sets of drawings of the Works as completed. The Works shall not be considered complete for purposes of taking over under the terms of the General Conditions of the Contract until the above documents have been supplied by the Contractor.

1.8 Installation Manual

The Contractor shall provide the Engineer and the Corporation with an Installation Manual covering erection and installation procedures and instructions to facilitate smooth erection and assembly of all equipment to be installed on site.

The instructions therein shall specify the exact procedures to be followed during installation, indicate data to be measured and recorded (adjustments, setting of limits, etc.) quantities, dimensions and tolerances to be checked, etc. The manual shall include information on handling and slinging the major pieces of equipment, erection tolerances, settings and adjustments and special precautions to be taken during erection and installation.

1.9 Commissioning Manual, Commissioning Report

The Contractor shall provide the Engineer and the Corporation with a Commissioning Manual which shall be similar in size and form to the Installation Manual and include procedures and instructions to be followed during the commissioning of all equipment to be installed.

The instructions therein shall specify the site testing and describe the exact procedures to be followed during commissioning and shall indicate all data to be measured (and where appropriate recorded in the manual itself) and all adjustments, settings of limits etc., quantities, dimensions and tolerances to be checked.

In addition to the above manual, the Contractor shall provide a Commissioning Report which shall be historical account of the commissioning procedures undertaken including a complete record of all settings and adjustments made and all tolerances checked.

1.10 Progress Report

During erection the Contractor shall, before the tenth (10th) day of each calendar month, submit 4 (four) copies of the monthly progress reports in a format acceptable

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to the Engineer, detailing the progress of the work during the preceding month. The report shall contain but are not be limited to the following information:

- A general description of the Works performed during the reporting period on each main activity and include any notable problems which were encountered.
- The total overall percentages of erection works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- The percentages of each main work activity completed during the reported month with reference versus the scheduled programme. Appropriate comments shall explain any differences.
- A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain any differences.
- A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and / or completion dates are different from those shown on the CPM programme, an explanation shall be given.
- A list of local manpower (by trade classification) employed during the reporting period.
- A list of expatriate personnel (by position) employed during the reporting period.
- A list of the Contractor's Equipment and materials presently located at the Site. Also a list of equipment and materials, which arrived at the Port of arrival and is in the process of being cleared through customs.
- Progress photographs of significant events. The Engineer may direct the inclusion of specific photographs if deemed necessary.
- Main items of temporary facilities constructed during the reporting period.
- A statement detailing the status of progress on the overall programme and how to regain any lost time or set-backs which may have occurred.
- A list of inoperable temporary equipment, and the estimated date when the repair will be completed.
- A statement concerning potential problems and recommendations on how they could be resolved.

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2 SPARE PARTS AND TOOLS

2.1 Spare Parts

All spare parts to be supplied shall be interchangeable with the corresponding parts of all the plant supplied under these Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components. Before issue of the Taking-Over Certificate the spare parts shall be checked and tested at the Site by the Contractor in presence of the Engineer.

Acceptance of any spare parts will not take place before the Contractor has submitted the complete final detailed list of all spare parts and tools.

All spare parts shall be protected against corrosion and shall be marked with identification labels in the English Language. The identification shall be in accordance with the agreed Plant Identification System.

All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage. The Contractor shall label and conveniently store all spare parts in racks provided by him in ready to use manner before handing over to the Corporation.

2.1.1 Mandatory Spare Parts

At least the quantity of general spare parts specified in various subsections of the Particular Technical Specifications (Volume-II, Section II) and the Schedule of Requirements (Volume II, Section III) shall be included in the Total Tender Price and consequently in the Scope of Works of the Contract.

2.1.2 Recommended Spare Parts

If any additional spare parts are recommended by the Contractor, these shall be stated in quantity and description in the Technical Data Sheets for each item and as per Vol. II, Section V.

Prices for additional recommended spare parts shall not be included in the Total Tender Price.

2.2 Mandatory Tools and Appliances

Contractors shall supply all mandatory tools & appliances as specified in particular technical specification (Vol. II Section II) and schedule of requirement (Vol. II, Section III). Contractor shall also suggest any addition and deletion in the list specified by the purchaser required for total assembly and disassembly of all parts of the supplied plant and accessories for maintenance of the plant.

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2.3 Recommended Special Tools and Equipment

The Contractor shall have to furnish the list of recommended special tools and equipment. Prices for recommended special tools & equipment shall not be included in the total tender price.

2.4 Foreign bidder shall identify the indigenous source (within the country of operation of the unit) for supply of spares and indicate the same in their offer.

3 DESIGN AND MANUFACTURE

3.1 Design and Construction Requirements

The following directions, information and technical requirements for layout, design and erection shall be observed as far as they are applicable to the plant to be offered. The technical requirements of the General Technical Specifications are valid for all parts of the Works except where they are varied by additional and/or special requirements, specified in the Particular Technical Specifications.

Whenever a Tenderer deviates from these Specifications, he shall furnish the data called for in the Technical Data Schedules and give a summary of and the reasons for all deviations in the "List of Deviations from Specifications". Failure to accomplish this may cause the elimination of his Tender, especially when a major deviation is involved.

Any changes of the design of any part of the plant which may become necessary after signing the Contract have to be submitted in writing to the Engineer for approval, being sufficiently substantiated and justified.

The plant shall be designed, manufactured, arranged and installed to provide functional design and neat appearance. All parts of the plant shall be arranged to facilitate surveillance, maintenance and operation. All control sequences shall be simple and rational.

The parts of the plant shall be designed and arranged so that they can be easily inspected, cleaned, erected and dismantled without involving large scale dismantling of other parts of the plant. They shall be designed, and manufactured in accordance with the latest recognized rules of workmanship and modern engineering practice.

The regulations, standards and guidelines listed in these Specifications shall be observed in the design, calculation and manufacture of the Plant.

All parts of the plant shall be suitable in every respect for continuous operation at maximum output under the climatic conditions and operating conditions prevailing at the Site.

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Special attention shall be given to plant, parts of which are delivered by different manufactures. Problems arising in this conjunction shall be solved by the Contractor and be defined in writing.

For individual items of the plant, materials and design are to be selected which are best suited for the operating conditions to which the parts in question will be subjected. Only such design and types of plant shall be offered which has confirmed its reliability in long-term continuous operation. Innovations cannot be accepted for the Main Tender but can be offered as an alternative proposal.

Manufacturers shall take appropriate measure to prevent the ingress of dust into any plant (such as bearings, relays, control and measuring equipment, etc.) which may be endangered thereby.

Suitable lifting eyes and backing- out bolts shall be provided where required or where they will be useful for erection and dismantling.

Pockets and depressions likely to hold water shall be avoided, and if not avoidable they shall be properly drained.

Parts of the plant principally intended for standby purposes shall be protected from any part of deterioration due to prolonged storage by careful choice of material and if necessary, by additional means; these should not reduce their continuous standby readiness.

All design details and layout matters shall be discussed in periodic meetings with the Engineer. The first design meeting between the Contractor and the Engineer shall take place within 28 days after the Date of Commencement. Further design meetings shall take place as agreed between the participants until the design work is completed.

3.2 Allowable Stress

The layout of the parts of items of plant shall fundamentally consider the most severe conditions to which they will be subjected during testing and operation.

The stresses which occur in a section of a part when subjected to the most severe operating conditions or test pressures shall not exceed 67 percent of the yield point of the material of the respective part.

If different stress values are given in the General/Particular Technical Specifications or in the relevant standards and regulations, then the more stringent values shall be applicable.

When exposing complicated steel castings or welded parts to a pressure test, the maximum allowable stress limit of 67 percent of the yield point may be exceeded

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locally in limited zones if these zones are small in extent and do not endanger the strength of the part. To check these stresses in the critical zones, the Engineer may require strain gauges to be mounted during pressure tests.

In the design of the plant, the maximum stresses due to normal operating conditions shall not exceed one-third of the yield point or one-fifth of the ultimate strength of the material, whichever is lesser, with the exception of safety elements which shall be designed to fail in the event of destructive overload, thus preventing damage to other parts of the plant.

Increased size or thickness, by at least 1 mm, is required for parts subject to corrosion or erosion and for parts mainly designed for rigidity.

The dimensions of the parts which are exposed to repetitive and alternating stresses as well as to impacts and vibrations shall take into account the safety measures approved in practice.

The calculations performed by the Contractor when dimensioning the main parts of the plant shall be submitted to the Engineer at his request.

3.3 Standardisation of Plant

Every effort shall be made to standardize parts and minimise costs of the plant throughout the plant in order to facilitate keeping stocks, maintenance, replacement, inter-changeability, etc.

The Engineer, therefore, reserves the right to request the contractor to use uniform types or makes of plant and materials. The Contractor shall not be entitled to claim extra payment due to this request. This request shall especially be applicable to small mechanical and electrical plant such as:

- Valves
- Thermometers
- Pressure gauges
- Flow meters
- Water level gages
- Sight flow indicators
- Terminals and terminal racks
- Indicating instruments and meters
- Auxiliary relays
- Contactors, fuses
- Motor protection switches
- Control devices
- Lights, bulbs, plugs, sockets.

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The types or makes to be used shall be decided later by the Engineer.

All instrument scales shall be written in the English of the Contract and in the international SI-System of units.

3.4 Quality of Materials and Plant

No welding, burning, filling or plugging of defective castings or any other components shall be permitted without the Engineer's agreement in writing.

Any steel castings which have been repaired by welding with the Engineer's consent shall be subjected (after the final heat treatment) to whatever crack detection, dye-penetration, ultra-sonic, X-ray (radiography) or any other tests which the Engineer may require. The cost of these and other additional tests shall be borne by the Contractor.

Where stainless steel cladding consists of plates welded to mild steel sections, the welds shall be adequate to ensure that the stainless steel is securely fixed for all conditions of load and wear. Generally, all stainless steel parts shall be welded with stainless electrodes. The thickness of the stainless steel cladding shall not be less than 3 mm.

3.5 Noise

The noise level caused by the installed plant shall not exceed the following values if not otherwise stated in the Particular Technical Specifications:

- machine hall, workshops, etc. max. 80 dB(A) at any place 1 m distant from operating plant
- offices, control rooms, first aid rooms, canteens, etc. max. 55 dB(A)
- residential areas, daytime max. 50 dB(A), night time max. 35 dB(A)
- emergency diesel generators max. 85 dB(A) at 7 m distance, open field.

The noise level definition and measurement shall be in accordance with latest ISO and IEC. The values stated shall be adhered to taking a normal civil construction into account. Particulars of the civil construction shall be submitted by the Engineer at the Contractor's request.

3.6 Security Precautions

All equipment shall be arranged so that it cannot be operated by unauthorised persons or incorrectly operated by the operating staff. All valves and switchgear shall be provided with locks to prevent access of unauthorised persons. Three keys shall

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be provided for all locks, each key being provided with a small steel or plastic label stating the equipment for which the key is provided. All keys shall be provided in lockable key boxes. All locks shall be different in order to prevent accidental operation of the wrong valve or other item of equipment but a master key system shall be incorporated.

3.7 Identification Plates

3.7.1 General

All duty labels, data, name plates and instruction plates shall be provided and fixed to all items to indicate the purpose and function of the Plant and its components so as to ensure safe and convenient operation and maintenance of the Plant. The type, size, information and position of them shall be subject to the approval of the Engineer. They shall be in English, of engraved stainless steel or similar approved material which shall be securely attached by screws, rivets or other approved means. Die stamped plastic is unacceptable.

3.7.2 Manufacturer's Nameplates

The following data shall be shown in accordance with the relevant standards:

- manufacturer's name and address
- plant's serial number and date of manufacture
- main design data.

As a general rule, standardised components, such as small or medium-sized electric motors, transformers, instruments, etc., may be delivered with the manufacturer's standard nameplate which shall be completed or replaced at the request of the Engineer.

The design of the Manufacturer's nameplates for the main components such as turbines, pumps, synchronous machines, governors, cranes, gates, main transformers, etc., shall be submitted for the Engineer's approval sufficiently in advance.

3.7.3 Functional Plates

Each part of the Plant including all valves, controllers, indicators, gauges etc., appearing under a certain symbol or number in functional diagrams, piping diagrams, in the Operation and Maintenance Instructions, etc., shall be equipped with a plate showing the same symbol or number and the corresponding drawing number.

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Schematic diagrams of oil, air and water piping engraved on stainless steel plates indicating positions of control elements in normal operating condition shall be fixed in required locations identified by the Engineer.

3.7.4 Instruction Plates

All plates showing designations or instructions for operation, safety, lubrication, etc., shall have a uniform design.

Adjacent to each oil filling cap of the Plant, a plate indicating the type and grade of oil shall be fixed.

3.8 Colour Code

The colour code for electrical and mechanical plant, such as generators, transformers, switchgears, parts of turbines, pumps, valves, gates, cranes, servomotors, piping for water, oil, air, combustible, poisonous or aggressive liquids or gases, etc., shall be according to relevant Indian Standard / International Standard or mutually agreed by contractor & purchaser.

Pipes shall be uniformly painted and be provided with colour bands in the colour given for the marking of pipes according to relevant Indian and International standards. The flow direction shall be marked by black arrows.

3.9 Workmanship

For general performance of workmanship, refer to 'Conditions of Contract' (Volume I, Section III).

3.9.1 Finished Surfaces

Where the finish is not indicated or specified, the type of finish shall be that type which is most suitable for the surface to which it applies and shall be consistent with the class of fit required.

Surfaces to be machine-finished shall be indicated on the shop drawings by symbols. Compliance with the specified surface shall be determined by the sense of feel and by visual inspection of the work compared to applicable "Standard Roughness Specimens". Or with roughness feeler gauge instruments. Both "Standard Roughness Specimens" and feeler gauge instruments shall be procured by the Contractor at the request of the Engineer.

3.9.2 Unfinished Surfaces

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As far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined to secure proper alignment.

Unfinished surfaces shall be true to the lines and dimensions shown on the drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts shall be filled in a manner approved by the Engineer.

3.9.3 Protection of Machined Surfaces

Machine-finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces of large parts and other surfaces shall be protected with wooden pads or other suitable means. Unassembled pins or bolts shall be oiled or greased and wrapped with moisture-resistant paper or protected by other approved means.

3.9.4 Roundings, Chamfers, Edges

The edges of surfaces to be painted shall be rounded (minimum radius 2 mm) or chamfered accordingly. This requirement must be stated in all shop drawings for the relevant parts.

3.10 Welding and Heat Treatment

3.10.1 General

All welds shall be as shown in the detailed drawings and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum.

The Tenderer shall submit with his Tender adequate information concerning the proposed:

- extent to which automatic welding techniques will be applied
- extent to which manual welding techniques will be applied
- extent to which it is the Contractor's intention to use pre-weld heat treatment, post-weld stress relieving, full anneal stress relieving or normalizing consistent with the thicknesses and types of material proposed
- weld electrodes, welding wire and flux which will be used with the selected plate material or materials
- standard tolerances for the deviations of mating weld profiles.

3.10.2 Welding

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Pieces to be joined by welding shall be cut accurately to size including the required allowances. According to the proposed welding method, the welding edges shall be sheared, flame-cut or machined to allow thorough penetration and fusion of the weld with the base material.

The cut surfaces shall be free of all visible defects, such as laminations, surface defects caused by shearing or flame-cutting operations. The edges and surfaces to be welded shall be free of rust, mill scale, grease, oil, paint or any other foreign matter. Welding over zinc primers shall be permitted subject to submission of a certificate of a recognized institution stating the pertinent limiting parameters for this welding procedure. In all other cases, welding over paint shall be prohibited; all painting materials next to the joint to be welded shall be removed well beyond the heat-affected zone.

Design, preparation, performance and testing of welded constructions shall suit the kind of stresses and the grade of risk, considering a supposed failure of the welded member.

The following table shows a general classification by means of numbers with the signification of each number explained thereafter.

Any structure not especially mentioned shall be classified by the Contractor and shall be subject to approval by the Engineer.

STRESS

	Compression	Bending, Tension >0,9 allowable stress	Alternating , Dynamic
Small risk			
Stairs, rails, doors, pipe supports, cable trays	0	0	1
Medium risks			
Cranes, roof trusses, bridges.	4	1,4	4,7
High risk			
Pressure pipes Turbine casings	1,4,7	1,2,4	1,2,4

Significations

0 = Without special prescriptions. Only skilled welders shall be employed which follow proven rules of workmanship.

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- 1 = Full penetration welds. The weld preparation shall allow the filling of the weld profile without defects. The root of double welded butt joints shall be ground before welding the second side. If the second side is inaccessible for welding, such single welded butt joints shall be built up against a backing strip.
- 2 = Weld ground flush. The weld shall be ground on both sides of the steel plate. The weld surface shall be finished so as not to reduce the plate thickness by more than 3%. Butt welds with a smooth surface and a chamber of less than 8% of the width of the top layer need not be grounded.
- 3 = Connections rounded. Where stresses are to be deviated already, the design shall care for a reduced notch effect. Welds shall be smoothly ground and rounded.
- 4 = Welder qualification test. All welders and welding operators shall have passed qualification tests in accordance with IS 1181 and IS 817 or the respective National Standard or rules of AWS – American Welding Society.
- 5 = Welding procedure test. The Contractor shall describe the proposed welding procedure. Further he shall prove with tests, that the properties of the weld and transition zone are at least equal to those specified for the base material.

The welding procedure test may be combined with the welder's qualifications test.

- 6 = Welding performance test, executed during fabrication at site welding. Run-off plates shall be tack-welded to one end of the plate under work. The weld shall continue on the run-off plate (test plate), welded in the same manner and under normal working conditions.

One test plate is required every 20 m of weld seam, but at least one of each weld type.

The laboratory tests shall cover the same range as the welding procedure tests.

On request by the Engineer test plates shall be welded in his presence.

- 7 = Ultrasonic and/or radiographic test. Depending on the location of the weld seams and the plate thickness, ultrasonic and/or radiographic tests shall be performed. The Contractor shall submit a proposal subject to approval by the Engineer. If not stated different in the Detailed Technical Specifications, 20% of the weld length shall be radiographed, but at least one film per weld type. The Contractor shall record the results of the ultrasonic and/or radiographic testing in these reports and drawings.

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8 = Marked with welder's stamp. The welder shall mark every seam welded by him with his number, so that it can be recognized until the end of the fabrication period.

3.10.3 Welding Qualifications

For welding of principal stress carrying parts, the standard of welding procedures, welders and welding operators shall conform to relevant Indian Standard or Standards equivalent to the requirements of the ASME Boiler and Pressure Vessel Code, Sections VIII and IX, or DIN 8560 and DIN 8563.

For welding of less important parts, the standards and qualifications shall conform either to the relevant Indian Standard or AWS Standard Qualification Procedure or equivalent standards.

All welders and welding operators assigned to the work shall have passed a performance qualification test. If more than one year has elapsed since the welder or welding operator passed his last test, then he shall again be tested.

Welders' and welding operators' test certificates shall be submitted to the Engineer.

3.10.4 Welding Work

The standard of welding works shall be in accordance with relevant Indian Standard or the "Standard Qualification Procedure" of the AWA (American Welding Society). In addition, the Contractor shall follow the statements regarding welding in the latest revisions of relevant Indian Standard or DIN 19704, DIN 19705, "Hydraulic Steel Structure Equipment".

All welding (except welding of thin plates or piping of small sizes) shall be performed by the electric – arc method and where practical, with process controlled automatic machines.

For any welding work, only the appropriate welding rod, either arc or gas, shall be used. The properties shall conform to the material to be welded as specified in the respective standards.

The electrodes for arc-welding shall be classified on the basis of mechanical properties of the as-welded deposited weld-metal, type of covering, hydrogen absorption, welding position of the electrodes and type of current.

Electrodes shall be used only in the positions and under the conditions of intended use in accordance with instructions with each container. Electrodes for manual welding shall preferably be of the heavily coated-type and shall be suitable for welding in any positions.

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Tacks shall be removed before welding.

Electrodes shall be dried in electric ovens before use.

After being deposited, welds shall be cleaned of slag and shall show uniform sections, smoothness of weld metal, feather-edges without overlap, and no porosity and clinker. Visual inspection of the ends of welds shall indicate good fusion with the base metal.

Where weld metal is deposited in successive layers, each layer shall be thoroughly peened before the next layer is applied.

Particular care shall be taken in aligning and separating the edges of the members to be joined by butt welding so that complete penetration and fusion at the bottom of the joint will be ensured.

All pinholes, cracks and other defects shall be repaired by chipping or grinding the defects to sound metal and re-welding. Where fillet welds are used, the members shall fit closely and shall be held together during welding.

The ignition of weld electrodes shall not be started at the plate beside the weld, but at the seam flanks to prevent detrimental increments of local hardness. Where ignition points of electrodes are discovered, they shall be ground appropriately.

Where auxiliary structural members are welded to components for the purpose of assembly or installation, these connecting welds shall be given particular care.

These auxiliary structural members shall be removed not by knocking them off, but by burning, followed by grinding the affected areas flush with the plate, without producing additional thermal stresses.

3.11 Preheating

Welding of mild steel shall not be undertaken when the plate temperature is 0 deg.C or below.

Mild steel plates conforming to IS 226 and thicker than 20 mm and plates conforming to IS 2062 and thicker than 25mm may require preheating of the parent plate prior to welding .materials or uneven thickness the thicker part shall be taken for this purpose.

Base metal shall be preheated as required to the temperature given in table below prior to welding or tack welding. When base metal not otherwise required to be preheated is at a temperature below 0 deg. C it shall be preheated to at least 20 deg. C prior to tack welding or welding. Preheat shall bring the surface of the base

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metal to the specified preheat temperature and this temperature shall be maintained as minimum interpass temperature while welding is in progress.

Min. Preheat and Interpass Temperature for Welding

Thickness of thickest part at point of welding	Other than low hydrogen welding electrode IS 226 steel or IS 2062	Low hydrogen welding electro or sub-merged arc welding IS 226 steel or IS 2062 steel
Upto 20 mm for incl. IS 226 and upto 25 mm incl. for IS 2062	None	None
Over 20 mm for IS 226 and over 25 mm for IS 2062 upto 40 mm incl.	100 Deg.C	20 Deg.C
Over 40 mm to 63 mm included	120 Deg.C	100 Deg.C

Preheating may be applied by external flame heating equipment by electric resistance or electric induction process such that uniform heating of the surface extending up to a distance of four times the thickness of the plate on either side of the joint is obtained.

Thermo-chalk or other approved methods shall be used for measuring the plate temperature.

All butt welds with plates thicker than 50 mm and all tension members with plates thicker than 50 mm shall require post weld heat treatment of entire assembly.

3.11.1 Heat Treatment

All weld-fabricated parts and castings except minor parts, parts where stress is not important or parts which are not specifically exempted from stress relieving shall be designed, fabricated, stress relieved and inspected in accordance with an approved "Boiler and Pressure Vessel Code". All such parts shall be stress relieved as a unit prior to final machining.

Heat treatment of welding-joints to be made in the field shall be performed according to the specifications for the welding procedure for the corresponding parts, which shall be submitted to the Engineer for approval.

3.11.2 Quality and Procedure Control

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Quality control methods, e.g. radiography, ultrasonic crack detection, etc., shall be done in accordance with the appropriate manufacturing code. However, the Tenderer shall indicate clearly along with tender the extent to which these methods shall be used.

Additional non-destructive controls can be required when it is desired to examine the acceptability of any welds when, in the opinion of the Engineer, serious doubt exists as to their quality; in this case, the expense of this examination shall be borne by the Contractor.

When required in the Particular Technical Specifications, the detailed description of welding procedure (including type of welding electrodes, sequence of welding seams, etc.) for certain parts of the delivery shall be submitted to the Engineer before commencement of manufacture.

3.11.3 Inspection of Welds

3.11.3.1 Visual Inspection

100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The length and size of weld shall be as per approved fabrication drawings. It may be slightly over sized but should not be under sized. The profile of weld is effected by the position of the joint but it should be uniform. In case of butt and corner welds, the profile shall be convex. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the weld run where welding has been recommended shall as far as possible be smooth and should not show any humps or crater in the weld surface. Weld shall be free from crater on the surface, under-cuts, slags on the surface and visible cracks. Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the sputter metal, scales, slag, etc. If external defects mentioned above are noticed the work shall be dismantled and redone duly replacing the defective materials including basic members.

3.11.3.2 Non-Destructive Examinations

For the important parts where high stress, high tensile, high pressure, high centrifugal force, repeatable stress or severe vibration are expected, shall be subject to following requirements of Non-destructive testing ;

Type of weld	Type of Inspection	Extent of Inspection
Groove weld on tension butt joint	Radiographic	100 %
Groove weld on compression butt joint	Radiographic	10 %

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Type of weld	Type of Inspection	Extent of Inspection
Groove weld on joints not suitable for radiographic inspection	Ultrasonic	100 %
Stainless steel overlay welding	Liquid penetrant	100 %
Bevelled edges and ends of all castings and plates which are to be field welded	Liquid penetrant	100 %
	Magnetic particle	100 %
Cross point welds	Radiographic	100 %
All other welds	Magnetic particle	20 %

Radio graphically examined welds shall have identification marks which should appear in radiographic film. All radiographic films of weld shall be submitted for approval together with location marks. Weld defects shall be repaired to meet the requirements of these specifications and shall be examined by the same method used to detect the original defect or as otherwise approved by the Engineer.

3.11.4 Rectification of Defective Welding Work

Wherever defects like improper penetration, extensive presence of blow holes, undercuts cracking, slag inclusion, etc. are noticed by visual inspection/other tests. The welds in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinding, if necessary and rewelded. The gouging shall be as far as possible done using gouging electrodes. Flame gouging shall be resorted to only in special cases with specific permission of the Corporation.

3.11.5 Acceptance of Welded Structures

The acceptance of the weld shall depend upon correct dimensions and alignment, absence of distortions in the structure, satisfactory results from the examination and testing of the joints and the test specimens as per IS, soundness of the welds and upon general workmanship being good.

Random D.P. test shall be conducted after welding on auxiliary structures.

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3.12 Corrosion Protection

3.12.1 Scope of Work

The Contractor's services shall cover the procurement of all materials, and the preparation and application of the painting and other protective coats as specified; all costs shall be included in the Tender Price.

3.12.2 Painting Materials

The Contractor shall provide a complete, reliable coating system. Coating materials shall be standard products of a paint manufacturer with proven experience in the field of corrosion of the type of plant to be supplied.

The Contractor shall submit for the Engineer's approval full details of the preparations, type of materials, methods and sequences he proposes to use to comply with the requirements for the protection of the structures, machinery and plant.

With regard to materials, the Contractor shall submit full details including the source of the basic raw materials, volatile matter content, nature of solvent, number of components, type of coat, coverage, time interval between coats and number of coats, compatibility of each coat with the previous coat, toxic properties, physical properties, shelf life, resistance against chemical attack, resistance against ozone and UV-radiations, compatibility with drinking water standards, etc.

He shall describe in detail the treatment he proposes to apply in order to give adequate protection during transport, site storage, building and concreting and subsequent erection.

The different coats of primer and subsequent coats shall be each of different shades of colour where practicable.

The Contractor shall submit to the Engineer for approval an overall colour scheme in accordance with the "Colour Code" for the finished surfaces of all plant. All final coats shall be in the colours approved by the Engineer. On request of the Engineer, painting samples for the different coats and colours shall be provided.

All pigment, paints and primers shall be delivered to Site in sealed containers packed by the manufacturer. The manufacturer's instructions for preparation and application of all painting and protective coats shall be strictly observed.

3.12.3 Painting Systems

"Painting Schedule", indicates painting materials considered suitable for the various parts of the work.

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The Contractor shall state in his offer the manufacturer and identification of the product which he proposes as an equivalent.

3.12.4 Surface Preparation

The term “preparation”, as used below, includes any cleaning, smoothing or similar operations that shall be required to ensure that the material to be painted attains suitable conditions.

To be ready for painting, a surface should be clean, dry and sound. The surface to be coated shall be free from any deleterious material liable to impair good paint adhesion or attack the coat.

For removing rust and mill scale on structural steel, piping and other steel surfaces, those parts suitable for sandblasting shall be sandblasted to a grade specified or required in accordance with relevant Indian Standard or SIS 05.59.00 (Sveriges Standardiserings Kommission) or the American’s SSPC-SP standard. This applies particularly to parts which will be in contact with water, exposed to heavy condensation and humidity or subjected to high temperature.

For health reasons, sandblasting with quartz sand shall be avoided.

All parts of the plant shall be sandblasted at the shop unless otherwise specified or approved by the Engineer. The sandblasted surfaces shall receive a shop coat with a quick-drying pigmented 2 –pack zinc-rich primer, unless otherwise specified.

Parts which cannot be sandblasted shall be cleaned of rust by power tool cleaning to the highest degree possible.

Hand or power tool cleaned parts of minor importance and not exposed to water or humidity may be coated with a quick-drying rust-proof primer formulated on a combination of synthetic resins (ready-mixed paint).

3.12.5 Execution of Painting

The Contractor shall supply full details regarding the extent to which the sandblasting and subsequent painting shall be performed in his workshop, on the Site or in situ after installation. A properly equipped paint shop shall be set up at the Site with a crew of specialists experienced and skilled in the preparation and application of protective coatings, to deal with all site protective treatment.

Unless otherwise specified under the present Specifications, painting shall be done in accordance with relevant Indian Standards or DIN 55928 “Protective Coatings for Steel Structures” or other equivalent standard approved by the Engineer.

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Painting operations shall only be made in dry weather and shall be interrupted in case of rain, fog or condensation. Painting shall not be carried out at temperatures below 5 degrees Celsius or at temperatures (air or surface) above 50 degrees Celsius and humidities above 80%. During the entire erection period the Contractor shall make available two sets of thermometers and humidity gauges.

Painting works shall only proceed when the prevailing temperature is 3 degrees Celsius minimum above dew-point.

Each coat shall be free from pores, runs, pinholes, and sags. Each coat shall be allowed to dry or to harden before the succeeding coat is applied. Where pore-free coat are specified, it shall be compulsory for the Contractor to prove this quality with adequate instruments.

Care shall be taken to maintain full paint thickness at all corners and edges and special attention shall be paid to application of protective coatings over welds, mitre joints, etc.

The first coat shall be applied (manual application by brush) immediately after sandblasting and shall be finished within six hours to avoid new corrosion.

Shop coats shall be checked for good quality and where necessary, before proceeding with the painting or coating operations at the Site, the Contractor shall clean and repair all shop coats which are defective or damaged.

Oil and grease shall be removed before mechanical cleaning is started. Clean cloths and clean fluids shall be used to avoid leaving a film of greasy residue on the surfaces being cleaned. Any required wash treatment shall be done in accordance with the manufacturer's painting instructions.

The Contractor shall consider that damage to paint-work during shipment, storage and erection is practically unavoidable and the application of all protective treatment should be programmed accordingly. Care must be taken to remove salt crystals deposited during sea transport and/or storage at a seaport, by thorough washing with clean freshwater. It is essential that before any coat of paint is applied, the surface shall be prepared as described above so that it is clean and free from all deleterious matter and completely dry.

Temporary or permanent welding shall not be permitted on areas where the welding will damage paint or other protective coatings, unless the areas of coatings which would be damaged thereby are accessible for repairing and inspection. Material which has been painting shall be handled with care and protected as necessary to preserve the coating in good conditions.

3.12.6 Quality Control

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The first and each successive coat shall not be applied without inspection and approval by the Engineer.

The minimum dry-film thickness prescribed in these Specifications shall be observed. Of each 100 m², one area of 10 m² will be measured for dry-film thickness. No measured thickness shall be less than the specified thickness.

Where the minimum thickness is not achieved, the coat shall be repaired to reach the specified minimum dry-film thickness.

The dry-film thickness shall be measured by approved gauges;

For checks on porosity, the Contractor shall furnish a DC variable high tension test instrument with built-in pore counter. The test voltage shall not exceed 2000 V. The tests shall not be performed within 0.5 m distance from uncovered, corrosion resistance surfaces.

Upon completion of each coat, the painter shall make a detailed inspection of the painting finish and shall remove from adjoining work all spattering of paint material. He shall make good all damage that can be caused by such cleaning operations.

A detailed inspection of all painting work shall likewise be made, and all abraded, stained, or otherwise disfigured portions shall be touched up satisfactorily or refinished as required to produce a first-class job throughout and to leave the entire work in a clean and acceptable condition.

3.12.7 Galvanising

Unless otherwise specified, all structural steel including ladders, platforms, hand rails and the like and all exterior and interior steel surfaces of outdoor plant, as well as bolts and nuts associated with galvanized parts shall be hot-dip galvanized, electrolytically galvanized or sheradised, as may be appropriate to the particular case.

Galvanising shall be performed in accordance with IS : 728 or other relevant Indian Standard or VDE Standard 0212 (Verband Deutscher Elektrotechniker).

Material for galvanizing: Only original blast – furnace raw zinc shall be applied, which shall have a purity of 98.5%.

The thickness of the zinc coat shall be:

- for bolts and nuts, approx. 60 micrometer
- for all other parts, except for hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 70 micrometers.

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- Pothead yard supporting structures and towers, approx 80 micrometers
- for hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 140 micrometer, in accordance with “VDEW, Druckrohrleitungen – Association of German Electricity Utility Companies, Steel Penstocks”.

Cleaning: All material to be galvanized shall be cleaned carefully of rust, loose scale, dirt, oil, grease, and other foreign matters. Particular care shall be taken to clean slag from welded areas.

Galvanising of plates and shapes: Where pieces are of such lengths that they cannot be dipped in one operation, great care shall be exercised to prevent warping.

Finished compression members of steel structures shall not have lateral variations greater than one-thousandth of the axial length between the points which are to be supported laterally. Finished tension members shall not have lateral variations exceeding 3 mm for each 1.50 m of length. Materials with sharp kinks or bends shall be rejected. All holes in material shall be free of excess spelter after galvanizing.

Galvanising of hardware: Bolts, nuts, washers, lock-nuts and similar hardware shall be galvanized in accordance with ASTM A 153. Excess spelter shall be removed by centrifugal spinning. The threads of bolts shall not be retapped after coating.

Straightening after galvanizing: All plates and shapes which have been warped by the galvanizing process shall be straightened by being re-rolled or pressed. The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. Materials that have been harmfully bent or warped in the process of fabrication or galvanizing shall be rejected.

Repair of galvanizing: Material on which galvanizing has been damaged shall be re-dipped unless the damage is local and can be repaired by soldering or by applying a galvanizing repair compound; in this case, the compound shall be applied in accordance with the manufacturer's instructions.

Soldering shall be done with a soldering iron using 50/50% solder (tin and lead). Surplus flux or acid shall be washed off promptly and the work shall be performed so as not to damage the adjacent coating or the metal itself. Any member on which the galvanized coating becomes damaged after having been dipped twice shall be rejected.

3.13 Metal Work, Floor Loads

3.13.1 Embedded Metal Work

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Unless otherwise specified, any foundations, wall and roof openings and coverings, concrete floor filling, sleeves in foundations and walls and trenches with floor plates for cables, will be provided by the Civil Contractor.

The Contractor shall supply and install all anchors, fasteners, embedded metalwork, piping, and sleeves associated with and required for the equipment to be installed under this Contract, except if other wise mentioned in the Specifications.

As far as practicable, the supports shall be of consistent design throughout and preferably of an approved proprietary type.

Attachments to concrete shall wherever practicable be by means of embedded inserts of an approved proprietary type.

The Contractor shall show the location and full details of all embedded components on his drawings and shall be responsible for the completeness and accuracy of his drawings and the information supplied to others. Anchorages to be embedded in primary concrete will be installed by the Civil Contractor to the Contractor's drawings. The Contractor shall be responsible for the adequacy and accuracy of the location of all embedded components supplied by him whether installed by himself or by others.

All adjustments to foundation levels, embedment, bedding and grouting of plant on foundations and cementing into walls and floors will be carried out by the Civil Contractor, but all levelling and adjusting of plant on foundations shall be carried out by the Contractor.

The grouting will be carried out by the Civil Contractor under the supervision of the Contractor and the mix and grouting pressure shall be approved by the Contractor. The Contractor shall satisfy himself that the grouting has been carried out to his entire satisfaction.

Any steel work which is to be built into the concrete foundations shall not be painted or coated unless otherwise approved or specified.

3.13.2 Miscellaneous Metalwork

Except where otherwise indicated elsewhere in the Particular Technical Specifications, the Contractor shall supply the following:

All platforms, ladders, guards and handrails necessary for an easy and safe access to plant supplied under the Contract. Handrails shall be of tubular steel construction except that the top rail shall be of flat bar, fitted with a formed plastic covering.

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The use of ladders shall be kept to a practicable minimum. Where ladders are approved for use they shall be of steel, have an inclination of 70° to the horizontal and a minimum width of 450 mm.

Safety guards at each point where normal access provision would permit personnel to come within reach of any moving equipment to be provided under the Contract.

All covers for pipe and cable trenches, required for completing the floors around and over plant supplied under the Contract will be supplied and installed by the Civil Contractor. Unless otherwise approved, floor plates shall be of an angular pattern.

Covers and curbing for dismantling hatches in main floors will be provided by the Civil Contractor.

3.14 Other Information

3.14.1 Earthquake considerations

The Heo Hydro Electric Project is situated in seismic zone (5).

For final design, the following values of Design Basis Earthquake (DBE) shall be taken into account :

Horizontal DBE : 0.24 g

Vertical DBE : 0.16 g

Under the most severe conditions of loading expected in normal operation, stresses in the materials shall not exceed the values as indicated in the next paragraph.

For materials used in the construction of the equipment, the maximum stress due to maximum normal rated load operating conditions shall not exceed one-third of the minimum yield point or one-fifth of the minimum ultimate strength of the material, whichever is lower. The minimum factor of safety under the worst conditioned shall not be less than 1.5 on yield point (Y.P.) or 3 (three) on ultimate tensile strength (UTS).

Parts subject to water pressure shall be designed to the applicable provisions of the ASME Code and welding shall be as specified and in accordance with ASME Boiler and Pressure Vessel code section 8, Division 2.

Standard products are not subject to the above conditions which shall be custom designed.

3.14.2 Construction Power

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The responsibility of arranging power for the work shall lie in bidder's scope. Grid power is currently not available in the project area. Therefore, the requirement would have to be met by installing diesel generating sets and the bidder shall quote their prices accordingly.

The bidder is requested to note that while it is not binding on NEEPCO for supply of power from the national or state grid or otherwise at any stage of construction of the project, there is a possibility that grid power may be available for project construction works in future. As and when grid power is available, grid power availed by the contractor shall be metered jointly including Employer and recovery shall be affected @ Rs. 30.00 per Unit which shall include grid power price per unit. Non-availability of power however, would not entitle the Contractor to make any claims whatsoever either for time extension or extra payments.

As and when grid power is available, the same shall be made available at 33 KV at one point near the Power House. The Contractor shall make his own network at required voltage levels for the work sites, complying with all statutory regulations. Contractor shall provide and install all the necessary transformers, switchgears, wiring, fixtures, electric poles, bulbs, (proper fencing wherever required) and other temporary equipment for further distribution and utilization of energy for power and lighting and shall remove the same on completion of the work. NEEPCO will not be responsible for any inconvenience caused due to the failure of power supply and no compensation for delay in works on this account will be entertained.

3.14.3 Storage of Equipment

It shall be the responsibility of the contractor to arrange proper storage of the equipment of the power house including special treatment of the same wherever necessary for which NEEPCO will provide suitable place in the Project area with no extra cost. However, in case of necessity of temporary storage of the equipment en-route to Project site in any area outside the Project, the same shall have to be arranged by the contractor at their own cost including treatment if necessary.

4 MECHANICAL PLANT

4.1 General

All mechanical plant and steel structures of any mechanical or electrical installation shall comply with this General Technical Specification and the requirements of the Particular Technical Specification.

All plant shall be of an approved, reliable design providing the highest possible degree of uniformity and interchangeability.

The design and arrangement of plant and installations shall facilitate erection, test, operation and maintenance.

All plant shall be pre-assembled in the manufacturers premises to an utmost extent.

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Revolving parts shall be truly balanced both statically and dynamically that when running at normal speed and at any load up to the maximum, there will be no vibration due to lack of such balance.

4.2 Bolts, Screws, Nuts, Etc.

All bolts, studs, screws, nuts, and washers shall be to the ISO metric system except other standards will be considered for specific applications. The extent to which other standards are proposed shall be indicated by the Contractor. Bolts and nuts shall be hexagonal headed. Sizes smaller than 4 mm shall be used only for instrument and relay internal connections.

Where mild steel bolts and nuts are used, they shall be of the precision cold forged washer faced type if commercially available in the size required. Alternatively, approved hot forged bolts and nuts, machined so that the undersides of bolt head and nut are faced and parallel to one another when assembled, may be used. In the latter case, a suitable fillet shall be machined between the bolt head and shank. All parts other than structural steel work, bolted together, shall be spot faced on the back to ensure that nuts and bolt heads bed down satisfactorily. Bolts machined from bar stock shall not be used without approval of the Engineer. All bolting material shall be adequately treated against corrosion before dispatch from the workshop. Mild steel nuts and bolts shall be zinc or cadmium plated.

All bolts or studs which will be subject to high stress and / or temperature shall be of approved high tensile material with nuts of approved material. All bolts and studs larger than 60 mm in diameter which are not accessible for tightening and un-tightening by commercially available pneumatic impact wrenches shall be drilled for heaters.

Washers shall be provided under bolt heads and nuts unless otherwise approved by the Engineer. All ferrous nuts and bolts on plant items where dismantling may be required during the life of the plant shall have their threads coated with an approved anti-seize compound. When in position, all bolts or studs shall project through the corresponding nuts by at least one thread, but this projection shall not exceed three threads, unless more length is required for adjustment. All nuts and set screws shall be securely fastened, to prevent loosening due to vibrations, using spring washers, lock nuts, split pins, self-locking inserts or 'Loctite' as appropriate for the purpose and material used.

The Contractor shall supply the net quantities plus 5 percent of all permanent bolts, screws and other similar items and materials required for installation at the Site. Any such rivets, bolts, screws, etc., which are surplus after the installation of the plant has been completed shall become spare parts and shall be wrapped, marked and handed over to the Corporation.

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4.3 Drives and Gears

All moving parts of machinery including shafts, couplings, collars, projecting key heads, gear wheels, rope/belt-drives shall be completely guarded to provide full protection. All set screws on revolving shafts shall be countersunk or suitably protected. The guards shall be of approved design and shall be fitted, where necessary, with inspection doors / openings. All guards shall be arranged so that they can be removed without disturbing the parts of the gears and plant which they protect.

Gears shall be designed so that all stresses are within allowable limits when the maximum loads are being handled. All gears shall be designed and calculated in accordance with relevant Indian standard, DIN or equivalent international standards, or widely-approved methods and to the individual experience of the manufacturer. On request of the Engineer, the manufacturer shall submit the calculation of the gears.

Where worm gears are used as a direct drive, they shall have the same load and time rating as the motors driving them. The gears shall work in oil and the temperature rise of the oil bath shall not exceed 40°C – 50°C under normal working conditions at site. The materials of the mating faces of worm wheel and worm shall be of a bronze / steel alloy.

Where practicable gear wheels shall be forced fit on the shaft and in addition, shall be keyed adequately to prevent any relative motion between the wheel and shaft. Where gears and couplings are secured in position by means of keys, they shall be easily accessible for tightening or removal. All keyways shall be machine cut. Couplings and collars shall be the shrouded or protected-type, free from projections of any kind.

All bearings shall be mounted in dustproof housings. Base of bearing supports shall be machined, and shall rest on machined-surfaces.

4.4 Lubrication, Lubricants, Fuel

Efficient means of lubrication, suitable for use under Site conditions, shall be provided for all moving parts.

Self-lubricating types of bearings shall be given preference, unless otherwise specified or practicable.

The contamination of the air, water and soil by lubricants and fuel shall by all means be avoided by applying of an appropriate design and layout of the plant in conforming to the latest recognised standards for modern engineering practice.

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The number of different lubricants oils, oils for pressure systems, etc., used in the items of plant throughout the plant shall be limited to a minimum in order to facilitate keeping stocks and maintenance.

The Corporation reserves the right to request the different Contractors to use certain types of lubricants, oil, etc. The contractor shall not be entitled to claim extra payment for this request. All different types of oil, lubrications, etc., shall be stated in the Tender and are subject to the written approval of the Engineer.

Unless otherwise stated in the Particular Technical Specifications, the necessary oil or grease fillings required up to the completion of Test Service Period, for bearings, pressure oil system, transformers, etc., including the necessary quantity for flushing and for the any oil change, shall be included in the Tender Price.

4.5 Piping, Fittings, Valves and Gates

4.5.1 General

Unless otherwise stated, all piping shall be designed for a “nominal pressure” PN 10. All piping shall be tested with 1.5 the design / nominal pressure. All required piping shall be furnished complete with flanges, joints, expansion joints, gaskets, packing, valves, drains, vents, pipe suspensions, supports etc. Steel structures, walkways, platforms, stairs and ladders shall be provided to cross pipes with diameters of 600mm and larger.

Welding as well as application of corrosion protection coats shall be done in the manufacturer’s shop as far as possible.

Flanged connections or joints shall be provided only as required for transport, installation or for reasons of dismantling for repair.

Metric (DIN) – flanges shall be used throughout. Welded flanges shall be weld-neck or slip-on flanges. The raised face shall be machined.

If the piping crosses over joints of civil structures of different settlement, the piping shall be provided with flexible joints to allow for vertical, horizontal and angular deviations.

Piping installation shall be sloped to prevent trapping of air bubbles. Where required suitable venting system shall be provided.

Adequate clearance shall be given to parallel pipes to allow for easy maintenance without disturbing other lines. All overhead piping shall have a minimum clearance of 2.00m from operating floors and platforms.

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4.5.2 Piping, Fittings

Steel pipes of a diameter < 100 mm shall be seamless, galvanized steel. Steel pipes larger than 100mm in diameter shall be made of galvanized carbon steel, unless otherwise specified in the Particular Technical Specifications. Pipe connections embedded in concrete shall be welded. Other pipe connections shall be flanged. The flange material shall be in conformance with the pipe material. The Contractor shall select the location of the weldometers as to ensure sufficient access for adequate touch-up treatment for corrosion protection.

Stress calculations of steel pipes shall be in accordance with relevant Indian standards / International Standards. “In no case, the superimposed stress of bending, tension, compression, etc., calculated to the shape variation hypothesis, shall exceed 0.67 of the yield point at maximum applied load at any point of the piping.

The maximum applied load shall take into account test pressure, water-hammer pressure waves, thermal forces, dead weight, etc. calculation on pipe stresses has to be submitted by the Contractor. The calculation will be subject to the Engineer’s approval.

The minimum steel pipe wall thickness shall be the “normal” or “standard” wall thickness as stated in the applicable standards.

Bends shall preferably be of the forged type. Mitred bends shall be allowed for larger sizes subject to the Engineer’s approval. For smaller fittings ductile iron will be permitted, too.

Fittings of the cutting-ring type are only acceptable for pipe diameters smaller than 12 mm.

4.5.3 Valves

Small valves and gates shall conform to relevant Indian standards or DIN 3230, “Conditions and Terms for Delivery of Valves.”

Generally, valves shall be leak-proof in either flow direction (except for non-return valves) when the nominal pressure is applied.

All valves with design pressure higher than PN 10 and diameters larger than DN 100 shall be workshop-tested to relevant Indian standards or DIN 3230 for tightness and soundness of materials.

The change of the disc seals of butterfly valves shall be possible without dismantling of disc and body.

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Valves shall close clockwise and be provided with position indicators. The drive units of motor-driven valves shall also be provided with hand-wheels for manual operation. The hand wheel shall be operable under all conditions and shall be independent of the motor drive. Further, it shall not be rigidly coupled to the motor drive and shall not compulsory turn when the motor is energised.

To facilitate operation, large valves and gates shall be provided with by-pass lines for pressure balancing, if required.

Valves spindles and pins shall be of stainless steel, spindle nuts and bushes of bronze, the body at lest of improved C.I.

Valves for water over 50mm bore shall be of external rising spindle type. Valves for oil shall be of non-rising type.

All pressure reduction valves, safety valves and similar components shall be workshop-tested and provided with a relevant as per Indian / International Standards.

All valves shall be readily accessible for both operation and maintenance, and where necessary for ease of operation the spindle shall be extended and an approved form of pedestal wheel shall be provided at a safe and convenient operating floor level.

All the valves shall be provided with means for padlocking. Exceptions shall be to the approval of the Engineer.

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4.5.4 Oil Piping

Piping of a diameter <50 mm shall be of non-corrosive material. Pipes larger than 50mm in diameter shall be made of seamless steel, unless otherwise specified in the Particular Technical Specifications, Oil pipes shall be as far as possible be prefabricated in the Contractor's workshop. They shall be welded except at terminal point and as necessary for erection and future dismantling. The Contractor shall select the location of the weldments as to ensure sufficient access for adequate touch-up treatment for corrosion protection.

All piping shall be hydrostatically tested at a pressure 1.5 times of the maximum working pressure. The entire pipe arrangement shall be subjected to the pressure test after complete assembly at the site.

Oil pipes shall not be embedded in concrete. Oil pipes crossing civil structures shall be routed through sleeves embedded in the concrete.

All oil piping shall be acid-treated to guarantee clean surfaces, completely free from welding residues.

This treatment shall be applied to workshop and site manufactured piping respectively.

The piping can either be treated in an acid-bath or being completely filled with acid. The duration of the treatment shall be approx. 6 hours. After that the piping shall be neutralised, flushed and corrosion protected for final installation.

4.6 Mechanical Instruments

All mechanical parts of instruments shall be suitably protected against shocks and vibrations, heat, humidity and splash water, etc.

Pressure gauges shall be provided with a damping liquid, e.g., glycerine, to compensate vibrations. Pressure gauges without damping means are not permitted, unless approved by the Engineer.

4.7 Pressure Oil Systems

Pressure tanks shall be designed, fabricated and tested in accordance with approved standards. The appropriate inspection certificates shall be furnished. If the pressure is held by compressed air or gas, then the requirements outlined in "Compressed Air Systems" of these General Technical Specifications shall also be applicable.

Oil sump tanks shall be provided with:

- suitable access openings

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- fine mesh strainer combined with a magnetic filter through which all oil returning from the servomotors shall pass. The strainer shall be readily removable for cleaning.
- dehumidifying air filter
- flush-mounted oil-level indicator
- filling connection with a suitable strainer
- drain connection with hand operated shut-off valve.

Sump tanks shall be installed so that the bottom of the tank and the drain connection are at least 40 cm above the floor. The bottom of the tank shall be inclined in the direction of the drainage. The pumps shall be removable without the necessity of emptying the tank.

Servomotors shall be provided with suitable connections for pressure gauges on the pressure and suction sides of the piston. Servomotor piston rods shall be provided with a hard chromium layer of approximately 0.04 mm thickness. A suitable protection for the piston rod seal shall be provided.

4.8 Compressed Air Systems

The provisions for safety of the entire compressed air system shall conform to internationally accepted standards. The standards proposed by the Contractor will in any case be subject to approval of the Engineer.

Vessels shall be of the cylindrical, vertical type and shall be mounted on a structural steel base. The inner surfaces of the vessels shall be protected with an appropriate paint coating. Each vessel shall be equipped with the following devices:

- 2 inlet sockets with valves
- 2 outlet sockets with valves
- 2 pressure safety valves
- 2 dial pressure gauges, one of the gauges with 3 electrical contacts
- 1 manhole or inspection hole
- 1 drain valve.

In case the pressure vessel is used for pressurised oil or water systems, the vessel shall further be equipped with:

- 1 transparent level gauge with shut-off valves at both ends
- level indicators with electrical contacts in a number as required or specified.

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Compressors shall be provided with:

- automatic lubrication
- air-intake filter and silencer
- thermometer for measuring temperature of the compressed air
- automatic shut-down if the discharge air temperature exceeds a predetermined, adjustable value
- discharging valves
- water drain valves
- water/oil separator
- pressure safety valve
- compressed air cooler
- non-return valve
- inlet pressure valve
- outlet pressure valve
- automatic moisture trap.

The water / oil separator shall be equipped with an automatic solenoid-operated drain valve to achieve automatic draining during standstill. The compressor stages shall be equipped with discharge valves, which shall close time delayed after start to avoid compressor start against full pressure.

The compressor shall be delivered as package units on common frame with the appropriately sized A.C. squirrel cage motor and the respective motor starter panels, ready for operation.

Each vessel shall pass a pressure test at 1.5 x nominal pressure for 8 hours in the manufacturer's workshop before coating is applied.

If requested by the Engineer, each compressor shall pass a performance test in the manufacturer's workshop to a standard mutually agreed upon, e.g. relevant Indian standard, DIN 1945, VDMA 436, without extra cost. The readily assembled compressors, controls, and switchgear shall be subjected to functional tests.

Each vessel shall be furnished with a test certificate of an independent, reputable underwriters' society.

4.9 Pumps (Water)

Non-submersible pumps and motors shall be mounted on common frames

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Material of the pumps shall be:

- | | |
|--------------|--|
| – casing | C.I. |
| – impeller | bronze / cast stainless steel. |
| – shaft | stainless steel |
| – sleeves | stainless steel / bronze |
| – wear rings | bronze / wear resistant stainless steel. |
| – keys | stainless steel |

The pumps shall withstand corrosion and wear by abrasive matters within reasonable limits.

Shafts sealed by packing glands shall be fitted with sleeves. Seals shall be exchangeable without extensive disassembly of the pump. Leakage water shall be directed to suitable drainage facilities.

Each pump shall be fitted with:

- check valve at the discharge side
- air and drain valve
- pressure gauges to indicate delivery and suction side pressure.

The size of the pump motor shall be 15% higher than the maximum power required by the pump at any operation point.

For submersible pumps, pump and motor shall be contained in the same casing and designed as a package unit with incorporated suction strainer and check-valve.

All submersible pumps shall be provided with quick connectors, guide rails, lifting chains etc. for easy removal in maintenance works.

The impeller shall be of bronze / cast stainless steel, and the material for the other parts as specified for the non-submersible pumps above. For dirty water pumps, the water passages of corrosive material shall be rubber-lined.

The motors of submersible pumps operating in potable water shall not be filled with oil or other media detrimental to potable water. Motors of submersible pumps operating in dirty water may be filled with oil.

Dirty water submersible sump pumps with the motors mounted on top of the pump shall be suitable for running dry continuously, without damage to seals, bearings, or motors.

For all other items, the requirements described for non-submersible pumps shall apply.

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For any pump, the overall pump-motor efficiency for the specified rated head and discharge shall not be less than 60%.

5 ELECTRICAL PLANT

5.1 General

The electrical items of plant of any electrical or mechanical installation to be provided under this Contract according to the Particular Technical Specifications shall – if not stated otherwise therein-fulfil the requirements of this Section.

All components shall be of an approved and reliable design. The higher extent of uniformity and interchangeability shall be reached. The design shall facilitate maintenance and repair of the components.

The plant shall be pre-assembled to the highest possible extent in the Contractor's or Sub-Contractor's workshop, complete with all devices and wired up to common terminal blocks.

The power supply and control cables shall be laid up to these common terminal blocks. The required control and protection devices, instruments, etc., within the different scopes of work shall be supplied and connected by the relevant Contractor.

Unless otherwise agreed, ratings of main electrical plant (infeeds, bus-ties) as selected or proposed by the Contractor, whether originally specified or not, shall generally include a safety margin of 10% under consideration of the worst case to be met in service. Prior to approval of such basic characteristics, the Contractor shall submit all relevant information such as consumer lists, short circuit calculations, derating factors, etc.

Short-circuit calculations shall be evaluated giving full evidence that every electrical component can withstand the maximum stresses under fault conditions, for fault levels and durations obtained under the worst conditions, e.g. upon failure of the corresponding main protection device and time delayed fault clearing by the back-up protection device.

All plant shall be suitable for the prevailing climatic conditions.

5.2 Standards

The design, manufacture and testing of all plant and installations shall strictly comply with the latest edition of the relevant IEC publications & Bureau of Indian Standard.

5.3 Colour Code

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In general, the colour code for electrical plant shall be as described in this specification..

5.4 Electric Motors

5.4.1 General

All motors shall be of approved manufacture and shall comply with the requirements of this Chapter. Motors of the same type and size shall be fully interchangeable and shall comply, as far as applicable IS / IEC Standard motor dimensions.

The general construction shall be stiff and rigid, no light metal alloy casings will be accepted. All precautions shall be taken to avoid any type of corrosion.

All motors shall be fitted with approved types of lifting hooks or eye bolts as suitable.

AC motors shall have squirrel cage type rotors.

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5.4.2 Rating

The rating of the motors shall be adequate to meet the requirements of its associated equipment. The service factor, being the ratio of the installed motor output to the required power at the shaft of the driven machine at its expected maximum power demand, shall be applied as follows:

<u>Power Demand of Driven Machine</u>	<u>Service Factor</u>
Up to 5 kW	1.2
More than 5kW	1.1

AC motors shall be capable of operating continuously under rated output conditions at any frequency between 97% and 103% of the rated frequency and / or with any voltage variation between 85% and 110% of the nominal voltage.

D.C. motors shall be capable of operating continuously under rated output conditions at any voltage between 85% and 110% of the nominal voltage with a fixed brush setting for all loads. Unless otherwise approved, the speed drop between no-load and full-load shall not exceed 10% of non-load speed.

5.4.3 Starting

AC motors shall be designed for direct on-line starting. They shall be capable of being switched on without damage to an infinite busbar at 110% of the nominal voltage with an inherent resident voltage of 100% even in phase opposition. For starting the motors from the individual main and auxiliary busbars, a momentary voltage drop of 20% referred to nominal voltage should be taken into consideration. With 85% of the nominal voltage applied to the motor terminals, each motor shall be capable of accelerating its associated load to full speed with a minimum accelerating torque of 5% of full load torque.

5.4.4 Windings and Insulation Class

The insulation of all motors shall be of class F but maintain in operation the temperature limits of class B.

The stator winding shall be suitably braced to withstand the forces due to direct-on-line starting and transfer conditions as mentioned before. The winding envelopment and tails shall be non-hygroscopic. The stator winding shall withstand the maximum fault current for the period determined by the protective devices.

The rotor winding shall be designed to give trouble-free continuous service including repeated direct-on-line starting. The rotor shall be subjected to a 120% over-speed test for 2 minutes without showing any winding dislocation.

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5.4.5 Ventilation and Type of Enclosure

All motors shall be of the totally enclosed fan-cooled type, protection class IP 54, outdoor IP 55, according to IEC 144 & IS 4691.

They shall have a closed internal cooling air circuit recooled by an external cooling air circuit drawn from the opposite side of the driving end.

Where motors are installed outdoors, a weather proof design shall be chosen. A hole shall be provided at the lowest point of the casing for draining condensed moisture. Motors of size 132 and above according to IEC shall be equipped with automatically controlled heating elements for protection against internal condensation of moisture during stand still periods. Such AC heater shall be suitably fixed inside the motor casing, the leads shall be led to a separate LV terminal box and shall be controlled by thermostat.

Vertical motors shall be provided with a top cover to prevent the ingress of dirt, etc.

5.4.6 Bearings

As far as applicable, self-lubricating ball and roller bearings with solid faces shall be provided for all motors; vertical motor shall have approved thrust bearings. All motors with ratings of about 1kW and above shall be equipped with lubricators permitting greasing while the motor is running and preventing over-lubrication. Additionally, the bearings shall be fitted with grease nipples permitting the use of a universal grease gun.

Where sleeve bearings are being used, they shall be of the self or forced lubricating type. If forced lubrication is required, it shall be arranged common to both the motor and the driven machine and provisions shall be made to ensure lubrication during start-up and shut-down operations without the necessity to start an auxiliary lube oil pump. Self-lubricated bearings shall be equipped with an easily accessible oil reservoir with overflow pipe and oil collecting vessel.

All bearings shall be easily controllable during operation or stand-still without dismantling the bearings. The bearing shall further be protected and sealed against dust penetration and oil leakage.

In case of independent bearings, motor and bearing pedestals shall be fitted on a common base plate.

For the transport of motors equipped with ball or roller bearings, special bearing inserts shall be provided to prevent transport damage.

Service hour meters shall be installed if maintenance work such as regreasing, oil change etc. depends on the operation time of the motors.

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5.4.7 Shafts and Couplings

The motors shall be provided with a free shaft extension of cylindrical shape with key and keyway according to IEC 72-1 and with the motorside-coupling which shall be pressed on the motor shaft and be balanced together with it. A coupling guard shall be provided.

5.4.8 Terminal Boxes and Earthing

The terminal leads, terminals, terminal boxes and associated equipment shall be suitable for terminating the respective type of cables as specified in these General Technical Specifications and in the Particular Technical Specifications.

Terminal boxes located indoor shall have a protection degree of at least IP 44, located outdoor IP 55, if not specified otherwise in the Particular Technical Specification.

The terminal boxes shall be of ample size to enable connections to be made in a satisfactory manner. Supports shall be provided at terminal boxes as required for proper guidance and fixing of the incoming cable.

The terminal boxes with the cables installed shall be suitable for connection to supply systems with the short-circuit current and the fault clearance time determined by the motor protective devices.

A permanently attached connection diagram shall be mounted inside the terminal box cover. If motors are provided for only one direction of rotation, this shall be clearly indicated.

Terminal boxes shall be totally enclosed and designed to prevent the ingress of moisture and dust. All joints shall be flanged with gaskets of neoprene or similar material. For motors above 1 kW, the terminal box shall be sealed from the internal air circuit of the motor.

Depending on the size, the terminal box of motors shall be fitted either with an approved cable sealing-end or with a gland plate drilled as required and provided with suitable fittings for cable fixing and sealing. Such openings shall be temporarily plugged or sealed during transportation.

Terminal boxes shall permit the examination of the terminals without disturbing the cables or conduits.

For earthing purposes, each motor shall have adequately sized bolts with washers at the lower part of the frame.

In addition, each terminal box shall contain one earthing screw.

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5.4.9 Measuring and Monitoring

All motors (above 50 kW) shall be provided with slot temperature detection devices (resistance thermometers) embedded in each phase of the stator winding, the leads of which brought out of the motor terminal box.

Out of these measurements at least one max. temperature contact shall be derived either thermostatically or electronically giving alarm and / or trip the associated motor starter.

5.4.10 Noise Level and Vibrations

Under all operating conditions the noise level of motors shall not exceed 85dB (A).

In order to prevent undue and harmful vibrations, all motors shall be statically and dynamically balanced.

Vibration displacements or velocity shall be measured in accordance with relevant Indian Standards or DIN 45 655 for motor sizes 80 to 315 according to IEC. The results for all motors shall be within the "R" (reduced) limits.

5.4.11 Tests

Each motor shall be factory tested and shall undergo a test at Site. The following tests shall be performed under full responsibility of the Contractor.

Routine Tests:

Tests shall be conducted as per relevant Indian Standards / International Standards.

Site Tests:

- Measurement of insulation resistance
- Measurement of polarization Index.

5.5 LV Switchgears, Cubicles and Panels

5.5.1 General Design and Construction Features

Electrical switchboards shall be constructed of braced rolled steel sections, with recessed panels, and supporting structures for mounting of power and control cables. All steel work shall be made of min. 1.5mm thick sheet-steel.

To avoid wobbling of doors, rear or side covers, etc. they shall be adequately braced.

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The cubicles shall be of robust and rigid construction, of the self-supporting floor mounted type. They shall be supplied complete with lifting lugs and eye bolts, with all required base frames, anchors, fixing materials etc.

Cubicles mounted in rooms with computer floors shall have their own supporting structures made of steel profiles, being fixed to the concrete floor.

Wherever the correct operation of instruments and relays makes it necessary, adequate vibration and shock-absorbers shall be installed.

All panels and cubicles shall be of standard dimensions, having a uniform appearance.

The switchgears shall be of the indoor, completely enclosed (protection class IP42), metal-clad type with drawout mounted switching devices as specified or shown on the drawings.

The construction shall be such that the various components of the switchgears are segregated electrically from each other; it shall be possible to gain access to the circuit-breaker and to the cable box chamber in any cubicle without having to take the busbars out of service. Hinged doors and bolted panels shall be provided.

The terminal blocks, relays and instruments shall be located so as to be safely accessible while the plant is in service. Suitable interlocks shall be provided for preventing access to live parts.

All instruments, relays, and control and selector switches, indicating lamps, push buttons and trip levers shall be flush-mounted and located at convenient heights on the front of the switchgear in a logical and clear manner. The layout of these panels is subject to the approval of the Engineer.

Cast resin insulators are permitted within individual cubicles but bushings entering or interconnecting different cubicles (for example busbars) shall be of absolute fire-resistant type (for example epoxy-resin).

The design of cubicles shall facilitate a possible extension at either end.

The cubicles shall have front access and – if not specified for erection at the wall – rear access for easy cable termination work and for maintenance and repair of the main and auxiliary equipment accommodated in the interior. Means shall be provided to limit the opening angle of doors to about minimum 100°.

Cubicles and panels shall be provided with interior lighting, controlled by door switches.

The cubicles shall be complete with all locks, cable end boxes, colour coded busbars, internal wiring, terminal blocks and accessories.

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Busbars shall be suitably mounted in enclosed compartments running the full length of the distribution boards. Access to the busbars shall be possible only by removing bolted covers.

Opening the back or front door of any circuit-breaker cubicle shall not expose the busbars. Busbar connections laying outside the busbar compartment shall be insulated or eliminate hazardous accidental contact while working on other parts of the switchgear. Means shall be provided or expansion and contraction of the busbars resulting from temperature variations.

All switchgears, busbars and connections shall be capable of withstanding all electrical mechanical and thermal stresses they may be subjected to under normal or fault conditions.

Clearances between live parts and to earth shall be in accordance with the relevant standards.

Each cubicle shall be provided with devices for earthing the incoming cables, preferably each phase separately. Provision shall also be made for earthing the busbars. Such earthing shall be interlocked with the incoming circuit breaker(s). Safety interlocks shall be provided to prevent earthing of live parts.

An earthing bar with a minimum cross-section of 40 x 6 mm shall run the full length of the distribution boards. This bar shall be connected to the main earthing system, and all metallic parts not forming part of the live circuits and all instrument transformer terminals to be earthed shall be connected to it.

Regarding painting refer relevant pages of Volume II.

Each cubicle / panel shall be equipped with a suitable mimic diagram.

All panels / cubicles shall have approx. 10% spare room for mounting of future auxiliary devices.

Piping transporting water, steam or oil is not permitted in the cubicles.

Floor openings below cubicles shall be covered and sealed by the Contractor after laying of cables, etc., so as to obtain fire-proof and vermin-proof installations.

Where required gland plates with suitable glands shall be provided.

Phase rotation and colour markings shall be employed throughout the plant.

5.5.2 Switchgear / MCC Feeders and Starters

Circuit breakers, fused load break switches and motor starter units shall be of the withdrawable mounted type. Where two or more starters or feeders are contained in

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the same cubicle, they are to be separated by barriers of sheet steel or fire proof insulating material. The panels shall contain all respective starters and contactors with their main incoming and outgoing power feeders.

The drawout switching devices shall be mounted on trucks or slide in chassis having adequate guidance by greased sliding rails and / or rollers. They shall be connected to the busbars by means of a self-aligning plug and socket arrangements. Complete isolation of each circuit shall be attained by drawing out the switching device.

The main contacts shall have shutters which automatically close upon withdrawal of the switchgear. The withdrawal of large circuit breakers shall be facilitated by means of cranks, gears or other facilities.

The contacts shall be amply sized and sufficiently strong to withstand maximum short circuit currents and carry continuously the rated currents without damage or overheating of any kind.

The control circuits shall also be provided with plugs and sockets.

The withdrawable units shall have clearly marked service, test and isolated (ready for completed withdrawal) positions. A mechanical interlocks shall be provided to prevent withdrawal of the unit unless the main circuit has been opened. The unit shall positively be locked in the test position before it is manually released for complete withdrawal. The test position shall permit local and remote closing and tripping of the relevant switchgear with the main contacts isolated from the power circuit.

All circuit breakers shall be able to be padlocked at its open / racked out position.

All circuit breakers, load break switches, starters and contactors shall be suitably rated and controlled according to the electrical and mechanical performance and duties they are assigned for. They shall be of the continuously rated pattern generously rated to comply with the Site conditions and requirements. Automatically controlled feeders (motor feeders, outgoing feeders) shall be equipped with a time delayed automatic tripping device operating in case of voltage failure at the busbars or being actuated by another defined signal.

Motor feeders shall be equipped as follows:

LV Motors:

- HRC fuses with auxiliary contacts and load break switch, or
- fused load break switch, or
- circuit breaker with instantaneous over current protection
- starter combination

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- adjustable thermal overload and phase failure protection

Moulded case circuit breakers and miniature circuit breakers can be used if they are properly selected to stand the maximum short-circuit current.

All starter and contactor units of the same rating shall be interchangeable. Remote controlled motor starters rated 5kW and above shall include provisions for remote current indication.

Circuit Breakers:

Circuit breakers shall be of the trip-free type with a driving mechanism composed of a spring loaded, energy storing closing and tripping device. Remote controlled circuit breakers shall be provided with an electric spring loading driving motor, manual spring loading or others and control shall also be possible. Means shall be provided to prevent pumping.

The circuit breaker phases shall be separated by barriers of approved heat resisting, non-tracking insulating material. The LV breakers shall be provided with main and isolating contacts, and with suitable arcing contacts, magnetic arc quenching devices, arc chutes.

The spring release of the closing mechanism shall be affected by means of a DC solenoid coil and by means of a mechanical pull out handle. Tripping shall be effected by means of DC solenoid shunt trip coil and by means of a mechanical push-in button.

The closing mechanism can alternatively be of the AC solenoid coil operated and latched type.

The moulded case circuit-breakers shall have shunt trip coil and trip-free operating mechanism of the quick-break type. They shall have a thermal overload of 125% of the normal full load current and instantaneous magnetic trips which operate at currents exceeding 500% of normal full load currents or 600% of motor full load current whichever is applicable.

Miniature circuit breakers (MCB) shall be single- or three-pole with adequate current ratings. The operating as well as the overload mechanism shall be sealed. The mechanism shall provide positive closing, contact roll and wipe, trip-free action with follow through on opening. The contacts shall be of anti-welding silver tungsten tips fixed on high conductivity copper backings. The contacts of control relays and of higher rated circuit breakers and contractors shall be silver-plated.

Contactors:

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LV contactors shall be of the air break type with arc shields, according to IEC Standards. Butt contacts of the rolling, self-cleaning type shall preferably be utilized and all portions likely to suffer from arcing shall be easily removable.

When closed, the contactors shall withstand the system fault current determined by the next coordinated short circuit tripping device. The associated thermal overcurrent releases shall be adjustable in order to fit the motor requirements and the temperature compensated up to 70°C ambient temperature.

Load Break Switches:

The load break switches shall permit manual operation from the front panel but they shall be designed to allow mounting of a remote control device.

They shall have a padlocking device and self-cleaning contacts with a high resisting anti-arc and with quick-making and quick-breaking action, capable to switch the specified rated currents.

If suitable, the load break switches can be combined with the HRC-fuses.

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5.5.3 Switchgear / MCC Control

For local switchboard control all circuit breakers and motor-starter contactor units shall have:

- one (1) green-coloured illuminated push-button for “ON”
- one (1) red-coloured illuminated push-button for “OFF”
- one (1) position indicator of either the semaphore-type for circuit-breaker, electrically controlled, or indicating lamps, included above
- one (1) amber-coloured indicating lamp for fault indication of local protection equipment (tripping of protection relay or device, blowing of power fuse, tripping of miniature circuit breaker of control circuits). This lamp shall remain lit until cancelled by resetting of the device having caused the fault indication. Facilities shall be provided to repeat the alarms, individually or group-wise for remote indication or recording.

Remote-controlled incoming and outgoing feeders as well as motor starters shall be equipped with key-operated LOCAL-REMOTE selector switches.

The “OFF” control shall be effective at all locations independent of the selector switch position while the “ON” control shall be restricted to the set selector switch position.

All manual operated plant has mechanical indications clearly indicating the relevant position. Each bus section of a distribution board shall have a blue-coloured signalling lamp indicating that the control supply is healthy, and each cubicle a yellow-coloured signalling lamp indicating heater “ON”.

Indicating lamps shall be of an approved low consumption type. The hoods covering the lamps shall be made of transparent coloured glass moulds or any other equivalent heat-resistant and break-proof material and shall be either of the screw or any other approved type to facilitate replacement of the lamps.

All indication lamp fittings of similar use shall be of the same size and type. Where suitable, LED indicating devices are preferred to pilot lamps; they shall be of the multi-element type.

Lamp test facilities shall be provided on each panel. Up to 3 panels, forming an assembly, can be fitted with one common lamp testing device.

Individual panels or panel suites shall include indicating lamps for:

- Heaters on
- Control voltage

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– Alarm / Trip

Generally, all signal, monitoring and protection circuits as well as shunt trips of circuit-breakers shall be fed by the specified standard DC voltage(s). All other circuits may be controlled by AC contactor-operating circuits shall be controlled by AC with the contractor solenoids preferably designed for DC, with pre-connected rectifier bridges. Where required, latched contactors shall be provided. All aforesaid circuits shall be protected individually by means of miniature circuit-breakers with position monitoring. AC control circuits shall be derived from the relevant busbar system via supervised main fuses, isolating transformer and the above-mentioned individual miniature circuit breakers.

Closing of the circuit-breakers and contactors shall be possible between 85% and 110% of the rated control voltage. Holding of contactors shall safely be affected at 70% of the rated control voltage. Tripping devices shall operated at 50-120% of the rated control voltage in case of mains dependent and at 75-110% in case of separate control voltages (DC System).

For local control all motors, valves, drive etc., the following case-aluminium push-button station shall be provided:

- One (1) key operated selector switch having three positions; fixing the mode of operation of the drive with regard to the following criteria:
 - 1st Position “OFF” (there is no access to that drive nor by the incorporated push button nor by the superposed control system)
 - 2nd Position “Local” means, the drive can be operated only by the incorporated ON-OFF push button. (mainly used for tests and or maintenance purposes)
 - 3rd Position “Remote” The drive is controlled by the superposed control system only.
- One (1) “ON” – push button.
- One (1) “OFF” – push button.
- One (1) “Emergency OFF” – push button, which remains locked upon actuation and which can be released only by means of a special key. The effectiveness of this emergency push button shall not be restricted by any other facility, or whatsoever, for having a protection function for the human being.

5.5.4 Small Wiring

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All wiring within panels, racks, boards, etc. shall be PVC insulated standard copper wires.

The insulation material shall be of polyvinyl chloride (PVC), tropical grade, or of other approved type. The wiring shall be capable of withstanding, without deterioration, the conditions prevailing at the individual location of installation. The bare ends of stranded wires shall be provided with squeezed sleeves or pins.

All secondary wiring shall be arranged and protected to prevent it from being damaged by arcing or by mechanical effects.

Wiring shall be neatly run, bundled or in rigid PVC plastic wireways filled not more than 70%.

Cable cores and all secondary panel wiring terminated to terminals / terminal blocks shall be fitted with numbered ferrules of yellow, moisture and oil-resisting insulation material having a gloss finish, with the identification numbers clearly engraved in black being the same as for the relevant terminals. In case different terminal boards are arranged close to each other the ferrules shall contain the terminal board denomination and the terminal number. The ferrules shall be fitted in such a way that they cannot become detached when the wire is removed from the terminal. All internal wiring shall enter the terminal block at one side only.

Wiring shall terminate in one or more terminal blocks, arranged at the side or bottom of each panel or compartment. Internal wiring between instruments or other devices not using the terminal block shall be permitted within the same compartment only.

Terminal blocks shall be numbered consecutively beginning with 1 from left to right or top to bottom and shall consist of single "insertion" type terminals of non-tracking, non-inflammable synthetic plastic lined-up in one row. All terminals shall have two (2) separate pressure clamping plates suitable for connection of incoming or outgoing, stranded and solid conductors, respectively. Other solutions have to be approved by the Engineer.

Terminals with clamping screws in direct contact with the conductor are not acceptable. The following categories of terminals shall be provided and arranged as follows:

- A) terminals for power circuit (one group)
- B) terminals with short-circuit facilities for current transformer circuits (one group).
- C) terminals for measuring and control circuits, where required, with bridging facilities to the neighbouring terminal (one group).

All terminal blocks shall contain 20% spare terminals of category C, mentioned above. Insulating barriers shall be provided between each pair of power circuits and

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between the terminal categories. The height and the spacing shall be such as to give adequate protection to the terminals whilst allowing easy access to the same.

5.5.5 Tests

The workshop tests shall be performed in accordance with applicable standards. For the individual switchgear components (i.e. circuit breaker, load break switch, etc.), type and routine test certificates of the manufacturer shall be supplied.

The following site tests shall be performed:

- visual inspection
- megger test (to include plant and internal wiring but excluding electronic equipment)
- functional tests of controls, interlocks, measurements
- setting of protection relays; adjustment by means of special testing equipment and operational checks
- HV test as required by applicable standards.
- Any other site test if desired by the Engineer by NEEPCO.

5.6 Auxiliary Plant

5.6.1 Auxiliary Switches

Where appropriate each item of plant shall be equipped with all necessary auxiliary switches, contactors and devices for indication, protection, metering, control, interlocking, supervision and other services. All auxiliary switches shall be wired up to terminal blocks on the fixed portion of the plant.

All auxiliary switches and mechanisms shall be mounted in approved accessible positions clear of the operating mechanism and are to be protected in an approved manner. The contacts of all necessary switches shall be strong and shall have a positive wiping action when closing.

Control Switches:

Control switches for electrically operated circuit breakers shall be of the pistol grip or discrepancy type. They shall operate clockwise when closing the circuit breakers and anti-clockwise when opening them. The control switches shall be so designed as to prevent them from being operated inadvertently, and where switches of the discrepancy type are used they shall require two independent movements to effect operation. Discrepancy type control switches shall be so designed that when released by the operator, they return automatically to the neutral position after

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having been turned to the “closed” position and shall at the same time interrupt the control voltage supply to the operating mechanism of the circuit breaker.

Switches for other apparatus shall be operated by shrouded push buttons or have handles of the spade type; the pistol grip type shall be used for circuit breaker operation only.

Control, reversing, selector and test switches shall be so mounted, constructed and wired as to facilitate the maintenance of contacts without the necessity for disconnecting wiring.

5.6.2 Anti-Condensation Heaters

Each individual enclosure accommodating electrical plant which is liable to suffer from internal condensation due to atmospheric or load variations generally all equipment located outdoor shall be fitted with heating devices suitable for electrical operation at the specified standard AC voltage, being of sufficient capacity to raise the internal temperature by about 5°C above the ambient temperature. Heaters in motors and similar equipment shall be switched on automatically upon opening of the motor starter, and vice-versa. Heaters in switchgear/MCC cubicles, control cubicles, panels, desks, etc., shall be controlled automatically by adjustable hygrostats / thermostat (setting range about 50 –100% relative humidity). The electrical apparatus so protected shall be of such design that the maximum permitted temperature is not exceeded if the heaters are energized while the apparatus is in operation.

Heaters shall be equipped with a suitable terminal box. All plant, whether fitted with a heating device or not, shall be provided with suitable drainage and be free from packets in which moisture can collect.

5.6.3 Instrument Transformers

Current and voltage transformer are to be housed and designed to suit their particular duties. They shall meet the requirements of the technical specification and latest relevant approved standards for metering and for protection and be capable of withstanding without any damage or deterioration.

- the continuous thermal current rating of the associated switchgear and
- the maximum short-circuit level of the circuit for a period of one (1) second.

Separate cores shall be provided for protection and metering circuits. Switching of current transformer (CT) circuits is not permitted.

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All CT's shall be capable of carrying rated primary current with an open-circuited secondary winding for one minute without damage or deterioration. The secondaries of CT's shall be earthed with the earth connection easily accessible.

The nominal values of CT and PT secondary windings shall be as stated in particular technical specification. The instrument transformers shall have adequate accuracy, saturation factor and rated burden.

The Contractor shall determine the burdens and accuracy boards and earthed at one point in the circuit. Potential transformers shall be fused on the secondary side by means of miniature circuit-breakers with auxiliary contacts.

All measuring transformers shall be provided with a plant label giving type, ratio, class, output, serial number, and connections.

The Contractor shall supply manufacturer's test certificates on test and measurements to be performed in accordance with applicable standards. The CT's and their associated circuits shall be tested on Site by the primary injection method.

5.6.4 Electrical Connections

Bolted connections shall correspond to the applicable Indian or DIN Standards and have two washers and one spring washer. Bolt terminals of machines (motors, transformers, etc.) shall be equipped with secured nuts, two washers and spring washer, all the above elements being of corrosion-proof material or plated accordingly.

Tightening of such bolt connections shall be done with a torque wrench set to values to be given by the Contractor before commencement of erection work.

Busbar interconnection of individual units (switchgear / busducts / transformers) shall be done by flexible joints. They are to be rated as the respective busbars are, the length shall ensure the flexibility against vibrations and for thermal or operational displacements and also withstand the dynamic short circuit stresses.

5.6.5 Protection Devices

The main parts of the plant shall be protected and interlocked so as to prevent mal-operation and other fault occurrences, and to maintain safety during all operation phases.

Electric protection relays shall be the standard product of an experienced and reliable protection relay manufacturer. They shall be of the static or mechanic/magnetic, tropicalised type and be mounted in suitable dust proof and shock-absorbing casings. They shall not be affected by external magnetic fields or any other influence (radio, computer, signals, impulses, etc.) consistent with the

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place or method of mounting. Electro-magnetic relays shall have a transparent cover with appropriate seals.

The protection relays shall be equipped with all necessary auxiliaries such as tripping unit, time relay, external resetting device (hand reset flag with seal-in operation). The relays shall provide easy access for testing and setting purpose.

Pre-warning alarms shall be initiated as early as possible before the protection system trips, in order to enable the operators to take precautions. Tripping of a protection system as well as the sources of the protective action shall be indicated and recorded as an alarm.

Unless otherwise required for special purposes, protection relays shall remain in the tripped position until the operator resets the relay manually. The protection and auxiliary relays shall be grouped and mounted on plug-in modules or stationary-mounted on swing frame with separate plugs and sockets to feature easy replacement and testing. The construction shall be sturdy and such that all parts are easily accessible for adjustment. Relays installed in switchboards shall be arranged in compartments separated from the switchgear.

Besides the mechanical-operated flag type indicator, all relays shall have sufficient contacts and / or auxiliary relay contacts to perform all the tripping, inter-tripping, interlocking, indication and alarm functions required. Suitable nos. of Spare contacts shall be provided for later use. The contacts shall be silver plated or of the seal-in type with the main contacts adjustable. The relay contact rating shall be for the specified standard voltage and for 200% of the nominal passing current. The relay coil shall be able to operate properly at voltage variations of –25% to +15%.

Relays shall be capable of at least one million operations without any defect.

Testing of the individual relays shall either be effected by stationary-mounted or portable testing devices.

5.7 Cables

5.7.1 General

The Contractor shall provide the relevant design and engineering of the relevant cable systems and, in close co-operation with the other Packages-Contractors, prepare the cable installation drawings with cable routing, connection diagrams, and cable lists, details etc.

All cables and accessories shall be suitable for installation under site conditions (e.g. aggressive soil conditions, etc.).

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The Contractor shall select the most suitable cable routes and raceways ensuring a minimum of interference with other installations.

The maximum continuous current carrying capacity of each individual cable type and cross-section used shall be determined, taking into account site conditions. The resulting load reduction factors are subject to the approval of the Engineer. The conductor cross-section of each cable, shall be adequate for carrying the fault currents determined by the relevant short-circuit protection device when operating under the specified load conditions, without deterioration of the dielectric properties. All the above data and their calculation including the short-circuit calculations, shall from part of the documents to be supplied by the Contractor and same shall be approved by Engineer. All cables shall be designed to cope with a voltage drop of 3% maximum. Maximum temperature to be attained by the contractor or any part of the cables when in service at site under the climate conditions as indicated in specifications shall not exceed the limits as per the latest issue of relevant applicable standard.

The polyvinyl-chloride (PVC) used for conductor insulation and cable sheathing shall be of the highest quality, heat resisting type.

The cross-linked polyethylene (XLPE) used for insulation of cables shall be of the dry cured type.

Cable conductors shall be of annealed, high conductivity copper/ Aluminium conductors laid up and rendered smooth and free from defects likely to injure the insulations. Under no circumstances mid-joints of cable will be accepted.

The identity of the manufacturer shall be provided throughout the length of the cable by embossing the outer sheath with “name of Manufacturer – year of manufacture”. The letters and numerals shall be raised and shall consist of upright block characters. The gap between the identification marks shall not be greater than 200 mm.

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5.7.2 Power Cables

The L.V. power cables shall be of the extruded solid dielectric insulated type; HV power cables of 36 kV shall be of the cross-linked polyethylene insulated cables shall be capable of continuous operation at a highest system voltage as specified with a maximum conductor temperature of 90°C, and a maximum temperature under fault conditions of 250°C.

All conductors shall have coloured insulation according to the phase colours or, alternatively coloured plastic sleeves can be used at all cable terminations.

5.7.3 Control Cables

The control cables shall be of the multicore or standard, PVC insulated type withstanding without deterioration the conditions prevailing at the individual locations of installation. Cables for analogue signals shall have a common screen of metal tape, cores shall be twisted to pairs.

Within control and electronic circuits, the minimum cross-sections shall be adequate for the design of the plant.

Multicore cables with more than 7 cores shall have approx. 20% spare cores for future use.

Multi-conductor cables shall be number-coded and / or colour – coded or identified by other suitable means.

The colour-coding or other identification system shall be shown on the circuit / connection diagrams.

5.7.4 Cable Laying

As appropriate for the various locations the cables shall be installed in cable, conduit – or tray systems, cable trenches, etc. or directly laid in the ground.

Cables running inside buildings or concrete trenches shall be laid on trays. The trays shall be of adequate strength and size to carrying the specified number of cables, providing approx. 25% spare capacity. The design of such trays shall include a safety factor to avoid permanent distortion when supporting erection staff during cable installation. The trays shall be of suitable aluminium alloys or hot-dip galvanized steel standard materials.

In chemically-endangered areas all trays, supports, ladders, etc., shall be of hot-dip galvanized steel elements. Cable trays shall normally be of the ladder type consisting of bars with rings, evenly spaced (max. 500 mm) according to requirements. Perforated, covered metal trays shall be used. All trays shall be rigidly

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fixed on supporting steel structures, masonry or galvanized racks. Cable trays arranged one above the other shall be at least 300 mm apart in case of power cables and 200mm in case of control cables.

Cables laid on trays or racks shall be properly fixed or clamped. Supports and racks shall be arranged to facilitate removal or replacement of cables.

Cables branched from general raceways and directed to the relevant plant shall be suitably protected where required over entire length by e.g. galvanized steel conduits sealed at their ends against ingress of water. Conduits shall be fixed on steel structures, brickwork or be embedded in concrete floors or walls according to field requirements.

Conduits embedded in concrete or block work shall be of suitable rigid PVC type. Cables laid outdoors, across roads in concrete or foundations shall run in hard PVC plastic pipes or any other better quality material buried in the ground in a depth not less than 600mm or embedded in concrete foundations at suitable depth.

The cross-section area of such ducts shall be utilized to 50% only. Pipe ducts shall terminate in concrete manholes before entering buildings. Manholes and pull-pits shall be provided where required to facilitate cable installation.

Cables on brick walls or similar civil structures can be laid in conduits (painted galvanized steel conduits within the reach of persons or erection / maintenance devices, PVC conduits in other areas) or in prefabricated installation channels made of galvanized steel metal or plastic.

Unarmoured cables shall be properly protected against mechanical damage when leaving ducts or covered trench works and the like.

Fire-partitions shall be provided when cables are passing through different fire zones or when entering cubicles and panels.

Cable passages into buildings shall be sealed fire-and water proof.

Accessible cable galleries shall have fire-barriers at suitable spacings including normally open fire doors, which are closed automatically in case of fire.

The Contractor shall provide in due course all required information on cable ducts, trenches, manholes, block-outs, foundations, etc. which shall be constructed by the Civil Contractor.

Minor civil works like slotting or chiselling shall be included in this Contract. A distance of approx. 30 cm shall be kept to other services.

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Power and control cables shall be adequately spaced. Generally power and control cables shall run on separate trays. However at same location these cables may run in same tray and shall be adequately spaced.

The Contractor shall be responsible for any damage caused by him to the buildings, and shall be responsible also for making good finishing any cable liable to carry unbalanced currents.

The pulling, and fixing and terminating of cables shall be strictly in accordance with the manufacturer's instruction, using the recommended tools and appliances.

The following shall be applicable for cable installation in trenches:

- Cable trench covers shall be removed in sections, according to the progress of work.
- Removed covers shall be stored in such a way that they do not create a hazard to people or traffic at site.
- Cables laying in open trenches for more than two weeks shall be protected against such radiation.
- Open trenches shall be properly secured by red warning tapes both sides along the trench.
- Any cover, cable or cable tray having been damaged during installation shall be replaced by the Contractor.
- Cable trenches shall be cleaned from dirt, sand, etc. before closing.
- Trench shall be closed as soon as possible.

5.7.5 Cables conduits through concrete blocks

The interconnection of cables between power house and pothead yard shall be done through cable trenches. However, tenderer may quote cable conduits through concrete blocks as an alternative for interconnection of cables between power house & pothead yard.

5.7.6 Cable Terminations

For all termination of wires and cables, the insulation shall be neatly stripped without nicking the strands of the conductors. Cable lugs for power cables shall be of adequate size. Cable glands or clamps shall be fitted in all cases to prevent stressed on conductors or terminals. It is important that the sealing compound and sleeving used in terminations is selected to suit the service conditions under which the cable is to operate.

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No terminations will be accepted if the insulation readings, 24 hours after making off, are less than 100 megohms using a standard 500 or 1000 V “Megger” (MV and HV cables only).

Some slack cable in a loop or other suitable form is to be allowed at a convenient place in the runs where required.

5.8 Oil and Compound

5.8.1 Insulating Oil and Compound

The first filling of insulating oil and / or compound shall be supplied for any plant provided under this Contract requiring filling.

Oil and compound shall comply with the latest approved appropriate Standards and shall be delivered in strong, hermetically sealed new drums.

Where drums are stored on Site in the open air, they shall be kept in a horizontal position.

5.8.2 Oil or Compound Filled Chambers

All joints of oil or compound filled chambers, other than those which have to be broken, are to be welded, and care is to be taken to ensure that the chambers are oil-tight. Defective welded joints shall not be caulked but can be re-welded subject to the written approval of the Engineer.

Suitable provision shall be made for the expansion of the filling medium in all oil or compound filled chambers and the chambers shall be designed to avoid the trapping of air or gases during the filling process.

All wiring in the vicinity of oil-filled chambers shall be insulated with oil-resisting insulation of approved quality.

5.8.3 Oil Level Indicators

Oil level indicators of approved design shall be fitted to all oil containers.

The indicators shall be marked with the normal level clearly visible from normal access levels and shall be easily removable for cleaning.

5.9 Labels and Plates

5.9.1 General

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Labels and data plates shall be provided in accordance with applicable standards and as detailed hereunder.

The proposed material of the labels, size, exact label lettering and proposals for the arrangement of the labels shall be submitted to the Engineer for approval.

5.9.2 Plant Labels and Instruction Plates

Labels written in the Contract language shall be provided for all instruments, relays, control switches, push-buttons, indication lights, breakers, etc. In case of instruments, instrument switches and control switches, where the function is indicated on the device, no label is required. The label shall be fixed close to the devices in such a way that easy identification is possible. Fixing on the dial glass of instruments will not be accepted. The working shall conform to the working used in engineering documents.

Each separate construction unit (cubicle, panel, desk, box, etc.) shall be identified by its plant identification number. Cubicles and similar units shall also bear this identification number on the rear side if rear access is possible. The overall designation of each unit shall be given in the Contract language and – if required – also in a selected local language. These labels shall be made of anodized aluminium with black engraved inscriptions, arranged at the top section of the units. Manufacturers trade labels shall – if desired – appear in the bottom section of the units.

All plant inside cubicles, panels, boxes, etc., shall be properly labelled with their item number. The number shall be the same as indicated in the pertaining documents (wiring diagrams, plant list, etc.)

Instruction plates in the Contract and selected local language, the sequence diagrams or instructions for maintenance shall be fitted on the inside of the front door of the electrical switchboard.

5.9.3 Warning Labels

Warning labels shall be made of synthetic resin with letters engraved in the Contract and selected local language, where required in particular cases.

For indoor circuit – breakers, starters, etc., transparent plastic material with suitably contrasting colours and engraved lettering would be acceptable.

Details are stated in the Particular Technical Specifications or will be fixed at a later date.

5.9.4 Labels for Conduits, etc.

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The material shall be non-corrosive and the description be done with 4 mm high letters/ figures.

5.9.5 Labels for Cables

Each cable when completely installed shall have permanently attached to each end and at intermediate positions as may be considered necessary by the Engineer, non-corrosive labels detailing identification number of the cable, voltage, and conductor size.

The cable identification numbers shall comply with those of the cable list.

All cables in cable pits and at the entry to buildings shall be labelled utilizing the aforementioned type of label.

5.9.6 Rating Plates

Plant (machines, transformers, etc.) rating plates and other technical data/informative plates shall either be of the enamelled type or be of stainless steel suitably protected after engraving with a transparent paint.

5.9.7 Single-Line Diagrams

Each switchgear room shall be furnished with a durable copy of the final as built single-line diagram detailing all electrical data and denominations, separate for each individual switchgear / distribution board / MCC, placed under glass and frame / wall mounted at an approved location.

The same applies to the Station Single-Line Diagram one copy of which shall be arranged in the control room (s).

5.10 Key System for Electric Boards

Key interlocked switches shall be provided with Yale or other approved locks for locking in the neutral position. Similar locks shall be provided for selector switches for locking the switches in any of the positions.

6 INSTRUMENTATION AND CONTROL EQUIPMENT

6.1 Design Criteria

6.1.1 General

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All components shall be of an approved and reliable design. The highest extent of uniformity and interchangeability shall be reached. The design shall facilitate maintenance and repair of the components.

The plant shall be pre-assembled to the highest extent in the Contractor's or Sub-Contractor's workshop, e.g., shop welding of thermometer wells and other connections, wiring of boards, desks, etc., including internal wiring and installation of devices shall be carried out. Fragile instruments shall be removed transportation to site.

All components shall be suitable for continuous operation under site conditions.

Materials for instrumentation and control equipment including piping material which is exposed to the measured media shall be selected accordingly.

All components shall be compatible with other electrical, electronic and mechanical plant.

All instrumentation and control functions shall be shown on the piping and instrumentation diagrams. The symbols to be used shall be in accordance with IS/ISO Standard. The identification system (tag numbers) shall be in accordance with the plant identification system and is subject to approval by the Engineer. All measurements and alarms shall be listed in a measuring list of a standard from subject to Approval by the Engineer. For remote controls, a schedule of interlocks shall be provided. The features of automatic controls shall be shown in block diagrams.

Shielded cables shall be provided for the control and supervisory equipment where required.

6.1.2 Standards

If the Contractor intends to apply Standards and Regulations other than those specified, he shall provide the Engineer with two (2) sets of such documents, which shall be complete, unabridged and written in the Contract Language.

6.1.3 Sizes of Indicators, Recorders, Etc.

The meters, instruments and recorders shall be standard size, to be selected to guarantee unique appearance of switchgears, control panels, control desks etc. The front glasses shall be of the anti-glare type. The scales shall be 90° or 240° type.

Indicators on local control panels, MV and LV switchgears	72 x 72 mm or 144 x 72 mm
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Indicators on vertical sections of control desk in control room and on rectifier or converter panels	96 x 48 mm or 96 x 96 mm
Indicators on control panels in control room when incorporated in mimic diagrams	72 x 72 mm or 144 x 72 mm or 144 x 144 mm or 96 x 48 mm
Recorders	144 x 144 mm (for line and 6-point recorders) 288 x 288 mm (for 12-point recorders)
Pressure gauges and other dial type instruments (local)	preferably 160 mm diameter

The control switches, adjusters, etc., on the panels and desks shall harmonize with the utilized indicator sizes.

6.1.4 Special Local Conditions

If the prevailing local conditions require special measures, the following shall be observed for the I & C equipment:

- all local indicators shall be of stainless steel.
- all copper pipes shall be protected with an external plastic sheath.
- all external bolts and screws shall be of non-corrosive material.
- all secondary shut-off valves, balancing and drain / blow-off valves shall be of the non-corrosive type.
- all metallic instrument piping shall be protected with corrosion protecting painting, or shall be of non-corrosive materials.
- all I & C equipment exposed to sun shall be protected against direct sun radiation. This can be done by protection casings, sun shields, etc.
- all multi-core I & C cables installed outside the buildings shall be completely protected by means of closed cable trays, flexible conduits, etc. The individual cables from the terminal boxes to the instruments shall be protected as far as practicable.
- all I&C equipment shall be rated for tropical environmental conditions and shall be certified by the manufacturer.

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6.2 Tests

The single components and pre-erected assemblies shall undergo functional and routine tests in the Contractor's or Sub-Contractor's workshop. The ready mounted control and supervisory system shall undergo functional tests on Site prior to commissioning of the power plant.

Calibration tests shall be made on all important pressure gauges and other instruments as required by the Engineer.

6.3 Measuring Systems

Only electric measuring signals of 4 – 20 mA shall be transmitted to the control room. The output signal of transmitters shall be 4 – 20mA and linear over the whole measuring range.

The components shall quickly respond to any changes of the measured magnitudes. Measuring ranges of indicators, transducers, etc., shall be selected in such a way that the rated value of the measured magnitude covers approx. 75% of the range.

All local instruments shall, as far as practicable, be mounted vibration free to allow good reading. Wherever required, damping elements shall be used.

Corresponding systems shall be grouped together in local panels.

All local indicating instruments and test connections shall be included in the respective plant as integrated parts. The scope of local indicating instruments and test connections shall enable the operator to properly survey the plant, and shall also allow to adequately carry out all acceptance and other tests.

The binary sensors shall be fused separately and supplied with 24 V DC.

6.3.1 Flow Measurements

Flow meters shall be of electromagnetic type with high vacuum and abrasion resistance interior.

One NO and one NC snap action contacts shall be provided for maximum and minimum values. Error limit shall be less than 5% of the measured value.

The design and arrangement of tapping points, piping and valves shall be in accordance with relevant Indian Standards / VDI / VDE 3512.

6.3.2 Temperature Measurements

All wells for capillary type thermometers, resistance temperature sensors and thermocouples shall be of the weld-in type. Wells for thermometers and temperature

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sensors of the screw-in type shall be restricted to measuring points for lubrication oil, and to such measuring points where welding is not suitable, e.g., at cast-iron parts. Shop-welded thermometer wells be covered by screw caps for protection during transportation and erection.

Resistance thermometers and thermocouples shall be equipped with waterproof connection heads. Thermometer arrangements shall be such that the connection heads do not become warmer than 80°C, and the measuring inserts are easily exchangeable.

The temperature sensors shall be selected in such a way to minimize the number of different spare inserts.

Resistance temperature detectors shall be standard type platinum, (100 ohm at zero degree centigrade O degree C PT 100). The wire of resistance shall be wound on ceramic base. The RTD protecting tube shall be of the pipe thread screw-in type.

Temperature to be recorded shall be measured by means of resistance thermometers or thermocouples which can directly be connected to the recorders.

The use of dial-type contact thermometers shall be restricted to bearing metal, cooling water and oil temperature measuring. In all other cases, thermocouples or resistance thermometers and electric contact modules (monitors) shall be used. Glass thermometers or similar will not be accepted as contact thermometers.

6.3.3 Transducers

The transducers shall be solid- state type with an output signal range of 4-20 mA DC or 1 to 5 V DC, unless otherwise specified.

The rms ripple current shall be less than 1 (one) percent within the rated measuring ranges.

Each transducer shall be able to operate upto a load impedance ranging between 0 to 500 ohm without adjustment of output. Transducers shall have a minimum adjustment of output current $\pm 5\%$.

The transducers and their power supplies shall be designed so that no appreciable deviation in the output current is produced switching or other voltage transients in the supply. The output leads from the transducers to the main terminal block shall be shielded.

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6.3.4 Pressure Measurement

Pressure gauges shall be shock and vibration-proof (preferably by filling with glycerine) and shall be equipped with toothed wheels and toothed segments of the machined type. They shall completely be made of stainless steel.

Higher than rated pressure shall not deteriorate the pressure gauge or affect its calibration. The pressure gauges shall be equipped with a radial connecting stud, to allow the mounting on a gauge holder.

Pressure gauges with potentiometers will not be accepted for use as a pressure transmitter.

The error for pressure transmitters shall be limited to $\pm 0.5\%$.

Pressure gauges and transmitters for inflammable liquids shall have filled systems and the filling liquid shall be separated from the inflammable liquid by means of adequate isolating membranes.

Each gauge, pressure switch and transmitter for absolute or differential pressure shall be equipped with a pressure gauge isolating valve including a test connection of the screwed type M20 x 1.5mm so that such device can be removed without any disturbance of the plant operation.

Pressure gauges and transmitters for pressure of 10 bar and above, shall not be directly mounted on the pressure tapping point. They shall be mounted apart from the tapping point on gauge holders or gauge boards. Whenever possible, pressure gauges and transmitters shall be groupwise combined on racks or consoles.

Pressure gauges for high pressures shall be equipped with a relieve valve for safety reasons in case of leaks (with a rubber reverse flow check).

In case of flowing substances, the measuring point shall be selected in locations of undisturbed flow.

If the pressure is pulsating, the devices concerned shall be connected via flexible tubes or other pulse-absorbing means.

The design and arrangement of tapping points, piping and valves shall be in accordance with relevant Indian Standards / VDI/VDE 3512.

The scales shall have a diameter of 150mm with black letters and figures on a white ground. The calibration shall be in kg/cm².

The high and low pressure connections of differential pressure gauges shall be marked accordingly.

All casings shall be dust and watertight and be made of stainless steel.

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6.3.5 Vibration Measurements

The vibration probe shall be of Piezoelectric acceleration sensor or proximity type based on either eddy current or magnetic pickup. For reliability, it is always desired that two probes at right angles to each other shall be utilised.

The proximity vibration sensor shall be used for measuring the rotating parts vibration/runout. The sensor probe shall be electrically isolated where it is supported.

6.3.6 Level Measurements

The liquid level measurements in reservoirs and tanks with atmospheric pressure shall be made by means of pressure transmitter of mercuryless-type, by displacement-type transmitters or float-disc-transmitters. The errors shall not exceed $\pm 1.0\%$ of the total measuring range. Level switches shall be of packless construction; there shall be a minimum of moving parts.

6.3.7 Electrical Measurement

All Electrical instruments shall be of flush mounted design, dust and moisture-proof. AC Ammeters and Voltmeters shall have moving iron system of not less than 1.5 accuracy class for connection to the secondary side of instrument transformers. DC measuring instruments shall have moving coil systems of the same accuracy. Wattmeters shall have electro-dynamic measuring mechanisms or alternatively a moving coil mechanism if fed by transmitters. Wattmeters shall be suitable for unbalanced system.

All indicating instruments shall generally withstand without damage a continuous overload of 20% referred to the rated output value of the corresponding instrument transformers. Ammeters shall not be damaged by fault-currents within the rating and fault duration time of the associated switchgear via the primaries of their corresponding instrument transformers.

All instruments and apparatus shall be capable of carrying their full load currents without undue heating. All instrument and apparatus shall be rear connected, and the enclosures shall be earthed. Means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protected by fuses in the unearthed phases of the circuit installed as close as practicable to the instrument transformer terminals or where instruments are direct-connected as close as practicable to the main connection. All power factor indicators shall have the star point of their current coils brought out to a separate terminal which shall be connected to the star point of the current transformer secondary windings.

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When more than one measured value is indicated on the same instrument, a measuring point selector switch shall be provided next to the instrument and shall be engraved with a legend specifying each selected measuring point.

All instruments shall be of the flush mounting type and shall be fitted with non-reflecting glass and shall comply in every respect with the requirements of IEC 51. Except for instruments employed for plant performance tests all instruments shall have an accuracy class of 1.5.

Scales shall be arranged in such a way that the normal working indication is between 50-75% of full scale reading permitting an accurate reading. CT connected Ammeters provided for indication of motor currents shall be provided with suppressed overload scales of 2 times full scale. The dials of such Ammeters shall include a red mark to indicate the full load current of the motor.

Where directly connected Ammeters are provided for indication of motor currents they shall be supplied with overload scales indicating up to six times full load current. The dials of such Ammeters shall include a red mark to indicate the full load current of the motor.

Instrument scales shall be submitted for approval by the Engineer. All instruments mounted on the same panel shall be of same style and appearance.

Transmitter connected Ammeters shall have 90° or 240° circular scales calibrated 0-120%. The rated motor current shall correspond to 100% scale indication.

Energy meters shall be of the induction disc type with limits of error according to IEC 170. The casings shall be dust and moisture-proof and shall fit into the boards to permit reading without opening the corresponding front door. Disc and cyclometers of the drum-type shall be clearly visible through a window in the casing and the cyclometer shall be able to record for a minimum of 2.500 hours. Meters shall be suitable for unbalanced systems.

6.3.8 Digital type Instruments

The indicative element for each digital indicator shall be seven segment LED illumination type. The number of digits of each digital indicator shall be selectable to sent the required indication. The watt and the var indicators for the circuits where direction of power flow may be changed, shall be provided with “+” and “-” signs.

6.3.9 Position Measurements

Position transmitters of the potentiometer type will not be accepted. Inductive or capacitive type shall be provided.

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6.3.10 Contact Devices

Contacts of level switches, pressure switches, limit switches, and of all other devices shall be of the snap action type (SPDT). Contact devices for interlocking systems shall be separate, i.e., contact devices serving commonly for interlocking and other purposes will not be accepted.

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6.4 Alarm Systems

The alarm system shall provide all alarms required for a safe and reliable operation of the plant. Alarms shall be initiated locally, in the control room, individual or grouped as required. All alarms shall be recorded on the event recorder.

6.4.1 Alarm Annunciation System

The alarm equipment shall operate from a 220V DC supply and shall give audible and visual warning when any alarm or trip condition occurs, including fleeting alarms. "Accept", "Reset" and "Lamp Test" push-buttons shall be fitted to each set of alarm equipment.

The following systems shall be applicable:

- Upon occurrence of an alarm a horn or buzzer shall sound, and a pertinent window shall be illuminated with flashing light. The horn shall be cancelled by pressing a push-button. The flashing light shall be acknowledged by pressing an acknowledgement push-button. Upon pressing this button, the flashing light shall pass over to steady light. When alarm contacts reset to normal, the light shall flash slowly until an acknowledgement push-button has been pressed.
- The incidence of the first alarm shall initiate a continuously sounding bell and the flashing of the appropriate illuminated annunciator. The bell shall be silenced and the flashing of the annunciator changed to a steady illumination on the operation of the "Accept" push-button. The alarm shall remain operated until the initiating contacts have restored or until the "Reset" button is operated, whichever is the later.

When several alarms occur before the "Accept" button is operated the illumination of the annunciator of the first alarm shall flash and the annunciators of the subsequent alarms shall have steady illumination. Any alarm which occurs after the operation of the "Accept" push-button and before the first alarm condition has been cleared shall be as for a first up alarm.

Operation of the "Lamp Test" push-button shall illuminate all alarm annunciator lamps on that set of alarm equipment. Operation of the lamp test facility shall not operate any alarm sequence.

The alarm equipment shall incorporate an electrically separate pair of contacts for each individual alarm annunciator module which closes on the occurrence of an alarm and remains closed until the alarm is cleared. These contacts are for the remote indication of alarms.

The alarm annunciators shall have individual illuminated windows with the alarm conditions engraved on the front face. The individual annunciators shall be grouped

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to form multiway alarm units flush-mounted in the cubicle fronts. 20% spare alarm annunciators shall be supplied for each set of alarm equipment to allow for further alarms.

Buzzers (Chimes, Horns, Bells as appropriate) shall be installed in suitable locations and shall be arranged to sound whenever the main audible alarm is energized.

All fusing and miniature circuit-breakers shall be incorporated in the alarm system so that any and each miniature circuit breaker trip will be announced. These alarms shall groupwise be collected and be combined to group alarms. The group alarms shall be connected in such a way that identification of an announced fault within the respective group is easy.

Motor trips and circuit-breaker trips shall be announced with flashing lights via the indicating lamp of the control station. Acknowledgement of this flashing light shall be effected by operating the control push-buttons. Apart from the flashing light of the indicating lamp, such trips shall also be announced audibly by means of the horn and visually as group alarms on the alarm annunciators.

Means shall be provided for testing all alarm and indicating lamps at desk, panel and local panels.

6.5 Logic Controls and Interlockings

The open loop control and interlocking systems shall comprise all controls of motors, circuit-breakers, disconnecting switches, motorized valves, dampers, solenoids, etc., including all process interlockings to properly control the plant and protect the equipment.

6.6 Auxiliary Power

The Auxiliary power supply for control and protection systems shall be derived from the specified systems at standard voltage levels.

Where required, control and protection systems shall have duplicate in feeders with appropriate protection and change-over devices.

Great care shall be taken in the general design of the power supply to minimize the risk of failure and damages and to facilitate the detection of faults.

The closed control loops shall be individually protected.

For protection miniature circuit breakers with auxiliary alarm contacts shall be provide. The alarm shall be indicated by an alarm lamp in each cubicle and as a group alarm in the control room.

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For each distribution bus, a voltage supervision with alarm in the control room shall be provided.

In order to facilitate interconnecting network design, all components of the control system shall have a common reference, isolated from earth. This will allow the first accidental earthing of a circuit without disturbance, if this earth fault is repaired prior the second one occurs. For this reason, an insulation monitoring system shall be provided measuring the total resistance of the circuits against earth.

In addition, an earth fault detection system shall be provided for fault location. Insulation monitoring as well as fault location detection shall be automatically performed continuously during plant operation without interfering the control signals.

In case of power supply failure, it is necessary that all final control elements automatically switch to a fail safe condition, and the control loops transfer automatically to manual mode with necessary annunciation.

When the power supply returns, the systems shall remain in the latter mode.

7 TRANSPORT AND INSTALLATION

7.1 Scope of Work and General Requirements

Shipping, transportation, loading, un-loading, insurance during transportation (Marine & Inland) storage and erection, commissioning, site testing and trial-run shall be performed by or under the responsible direction of the Contractor.

Due to geographical location and prolonged monsoon in Arunachal Pradesh, the transportation assumes a critical consideration in completion of the project within the stipulated time schedule. The bidder is advised to have a total study of all aspects of transportation of equipment to site and should make schedule of transportation in accordance with the prevailing conditions at site. The bidder shall specifically understand that the Purchaser will do the general co-ordination of storage and erection works as well as civil engineering works of power house .An appropriate period for transportation shall be considered accordingly.

The Engineer will do the general co-ordination of storage and erection work as well as the civil engineering work under the different packages on site.

The delivery dates, transportation and erection periods and for all other associated activities indicated in the Contract Documents shall be strictly adhered to. Changes, which are unavoidable or necessary, will be regulated in accordance with the stipulations laid down in the General Conditions of Contract.

From the time of manufacturing until commissioning all parts of the plant shall be protected and insured at the Contractor's expense against loss & damage of any

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kind. Parts, which are damaged during transport, storage, erection or trial operation, shall be replaced at the Contractor's expense.

7.2 Packing and Transportation

7.2.1 Packing and Marking

The Contractor shall prepare all plant, devices and materials for shipment to protect them from damage in transit, and shall be responsible for and make good all damages due to improper preparations, loading or shipment.

After the workshop assembly and prior to dismantling for shipment to the Site, all items of machinery and plant shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so that are clearly visible.

Dismantling shall be done into convenient sections, so that the weights and sizes are suitable for transport to Site and for handling on the Site under the special conditions of the Project.

All individual pieces shall be marked with the correct designation shown on the Contractor's detailed drawings and other documents (packing, lists, spare part lists, in Operating and Maintenance Instructions, etc.).

Each piece, separately shipped, or smaller parts packed within the same case or box, shall be legibly, marked to show the unit to which it is a part and match-marked to show its relative position in the unit.

Unit marks and match-marks shall be done preferably by punching the marks into the metal before painting, galvanizing, etc., and shall be clearly legible after painting, galvanizing etc. In labelling, the Contractor shall endeavour to use as few designations as possible, and each part of identical size and detail shall have the same designation, regardless of its final position in the plant.

All parts of the plant shall be packed at the place of manufacture; the packing shall be suitable for shipment by sea and for all special requirements of the transportation to Site. Where necessary, double packing shall be used in order to prevent damage and corrosion during intermediate storage.

All identical members shall be packed together, if reasonably possible, in a form convenient for shipment and handling.

Small items shall be packed in boxes and large items shall be protected where necessary, by timber, straw and sacking. Drums shall be used for electric cables, steel ropes, steel wire and similar materials. All bolts, nuts, washers. etc., shall be

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packed in containers. Each container shall include only bolts, nuts or washers of identical size.

All parts shall be suitable protected against corrosion, water, sand, heat, atmospheric conditions, shocks, impact, vibrations, etc.

All electrical parts shall be carefully protected from damage by sand, moisture, heat or humid atmospheric conditions by packing them in high pressure polyethylene foil. Where parts may be affected by vibration, they shall be carefully protected and packed to ensure that no damage will occur while they are being transported and handled.

Spare parts shall be packed separately and designated as specified and shall be delivered properly and adequately packed for several years' storage. All packing costs shall be included in the scope of Work.

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7.2.2 Shipping Marks

The Contractor shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked on at least two sides as follows:

Consignee:	} To be decided during placement of L.O.I.
Contract No.:	
Port of destination:	
Item number (if applicable) Package number, in sequence and quantity per package:	
Description of Works:	
Net and gross weight, volume:	

7.2.3 Packing Lists

The Contractor shall provide the Corporation with one (1) original and two (2) copies of all shipping documents and relevant packing lists of each shipment of equipment items after the same has been shipped. One copy (1) of the packing list shall sent to the Corporation's Representative. All packing lists shall contain the name of the Contractor or supplier and shall show the complete markings on each packed box or crate that has been shipped. Separate packing lists shall be prepared for each and all shipments made. One copy of the packing list shall be placed inside each box or crate, and one copy inserted in a weatherproof envelope affixed to the outside of each box or crate.

7.3 Equipment Handling and Storage

7.3.1 General

All equipment shall be handled very carefully to prevent any damage or loss. Wires, chains, ropes slings etc. used for handling of the equipment shall be appropriately protected by sleeves or other means to prevent damage to the equipment.

The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the storage shall be moved to the actual location at appropriate time so as to minimize risk of damage of such equipment at site.

The Contractor shall provide means for all unloading and reloading for all consignments of plant, both during transport to Site and on the Site. Consignments shall be unloaded immediately on arrival at Site. The Contractor is required to take

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the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc.

All large parts of the plant shall be brought, as far as possible and practicable, directly to their final place of erection.

7.3.2 Storage Area and Warehouses

The Engineer will designate areas where the Contractor may store parts of the plant. The Contractor shall, at his own expense, render such areas suitable for the respective purposes.

The required space for the storage facilities will be provided suitably levelled and compacted on the Site.

The warehouses shall be weatherproof, with good ventilation and solid floors. The floors of the warehouses and storage areas shall be designed to carry the loads imposed on them by the stored parts. The following parts shall be stored inside enclosed warehouses:

- Electrical parts with electrical devices attached, electric motors and excitation equipment
- Instruments, welding material and equipment, bolts, pins, packing, tools, insulation materials A
- All small parts and parts of the plant which already have been finally painted.

All electrical panels, control gears, motors and such other devices shall be properly dried by heating before they are put into storage. If panels equipped with anti-condensation heaters will be stored over longer period of time (more than one month), the Contractor shall assure that the heaters are energised.

Motor bearing slip-rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and motors shall be periodically rotated to prevent corrosion due to prolonged storage.

If large parts are stored in the open air, they shall be provided with weather resistant and fire-resistant covers. Electrical parts, which are not packed in heavy-duty polyethylene foil and those so packed, but whose packing has been damaged, shall be kept in suitable place from the moment of storage to the moment of installation.

All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the powerhouse shall be protected from weather or humidity.

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The consumable and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage

The Contractor shall ensure that all the packing materials, and protection devices used for the equipment during transit and storage are removed before the equipment are installed. The packing materials and protection devices shall remain the property of the Purchaser and shall be handed over to him by the Contractor after completion of the work. In case, the Contractor fails to return the packing materials and protection devices, the Purchaser shall have the discretion to deduct from the Contract price at a reasonable amount on this account.

If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the Engineer will have the right to get it moved to the areas earmarked for the Contractor at the Contractor's cost.

The contractor shall maintain an accurate and exhaustive record that details out the list of all equipment received by him for the purpose of erection and keep such record open for inspection of the Engineer at any time

7.4 Transportation Limits

The project road from Kamba-Mechuka road to Heo Power House is being built as per the following specifications:

- i) Single lane carriage way width: 3.75M
- (ii) Minimum Formation width: 7.75M
- (iii) Maximum vertical gradient: 1 in 15
- (iv) Vertical Ruling gradient: 1 in 20
- (v) Minimum Radius of curvature: 20.0M

Detail Geometric design shall be done as per IRC manual for hills road.

The bailey bridge over yarjep river shall be of 40R specifications, having a clear width of 4.25 Metres (from truss to truss).

Therefore, the maximum width of the largest consignment shall be computed accordingly.

The maximum weight of the consignment shall also be finalized as per the bailey bridge specifications.

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The bidder is requested to visit site and carryout detail survey to ascertain transportation constraints, if any, in the Kamba Mechuka Road as well as the project roads to Power House and Valve House.

8 SITE INSTALLATION AND ERECTION

8.1 Preparation of Site Installation Works

Prior to commencement of installation, the Contractor shall closely inspect the Site and all the foundations and other structures on which parts of the plant supplied under this Contract will be installed; he shall check that the foundations conform to the installation drawings.

The result of this check shall be reported to the Engineer in due time to allow any errors to be corrected before the commencement of erection. All parts of the plant shall be cleaned carefully of all contamination such as dust, sand, rust, mill scale and other dirt prior to installation.

8.2 Reference Points

The Engineer will provide major centre lines and datum levels only. The Contractor shall be responsible for transferring those required to carry out the Works. The Contractor shall employ a competent surveyor for setting-out of all datum lines including the constant checking and maintenance of the setting-out until the completion of his works.

The Contractor shall provide all necessary pegs, profiled templates and centre lines and shall establish all such permanent markings and recovery marks as may be required by the Engineer for checking the Contractor's setting-out. The Contractor shall be responsible for rectifying, at his own cost, all work rejected by the Engineer due to errors in setting-out.

All bench marks, kerb marks, pegs and signals on the surface, alignment pins and the like put in by the Engineer for the purpose of checking the Contractor's work or as permanent survey marks will be under the care of the Contractor during the period of the Contract. He shall, at his own expense, take all proper and reasonable care and precautions to preserve and maintain them in their true position where such marks are within or adjacent to his work area. In the event of their being disturbed or obliterated by any cause whatsoever, they may, if so determined by the Corporation, be replaced by the Engineer at the Contractor's expense.

The Contractor shall be responsible for the true and proper staking-out of the works and levels of reference given by the Engineer in writing, for the correctness of the positions, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour in connection with this.

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The checking of any staking-out or of any line or level by the Engineer or the Engineer's Representative shall not in any way relieve the Contractor of his responsibility for its correctness.

8.3 Installation Work

8.3.1 General

All transportation and handling of the plant from the place of storage to the place of installation shall be carried out by the Contractor. He shall also provide all hoisting equipment, staging and scaffolding, winches and wire ropes, slings, tackles and all other appliances and temporary materials. The erection staging and scaffolding shall be provided with coverings and barriers and shall guarantee safe working conditions.

The Contractor shall comply with all applicable and approved safety regulations while carrying out the works at Site and with all reasonable requirements of the Engineer. This stipulation shall in no way release the Contractor from any obligation concerning his liability for accidents and damage. He shall be responsible for adequate protection of persons, plant and materials against injuries and damages resulting from his operations.

The plant or parts to be installed shall not be over-stressed during the process of installation.

The Contractor shall be responsible that the installation of all plants is properly executed to the correct lines and levels and in accordance with the manufacturer's instructions and the Contract requirements.

The alignment of the plant shall be done exactly; the tolerances indicated by the Manufacturers or in the drawings shall be kept.

Setting of parts to be aligned shall be performed by means of fine measuring instruments. All erection clearances and settings shall be given to the Engineer. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc.

8.3.2 Standards

The procedure followed and precautions taken and the equipment and materials furnished/used in the installation work shall in general conform to the applicable Indian and International Standards. The Contractor for the site installation work must strictly observe the following standards:

- Indian Electricity Rules, 1956.
- Indian Electrical Code

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- Indian Boiler Regulation and all other applicable statutory rules and regulations for pressure vessels.
- Indian Factories Act.
- Standard of the National Fire Protection Association (USA).
- Or any other standard or acts – not specifically mentioned but required for the safe, smooth & successful erection.

8.3.3 Embedded Parts

Anchor bolts, base plates, anchor rails, etc. to be embedded in the first stage concrete shall be delivered in due time with instructions and/or templates to facilitate the bringing in of such parts into the Civil works.

All parts to be embedded in concrete shall be set accurately in position and shall be supported rigidly to prevent displacement during the placing of concrete. Adjusting screws and bolts shall be drawn tight and secure adequately. Steel wedges shall be secured by welding. Wooden wedges shall not be used.

The Contractor shall verify carefully the position of all parts to be embedded before concrete is poured. All important measurements and dimensions shall be recorded. Copies of these records shall be given to the Engineer for checking and approval before items are built-in to the works.

The Contractor shall be responsible for the supervision of the building-in work. He shall state the allowable concreting or grouting rates and amount required for sequence of pouring at the different places. After concreting, the control measurements shall be verified again, indicated in the above-mentioned records and submitted to the Engineer.

8.3.4 Temporary Bracing

The Contractor shall provide all necessary anchors and braces to ensure the alignment and stability of the parts to be installed. All temporary anchors and bracings shall take care of all dead load, wind load, seismic and erection stresses, e.g., during concreting, and shall remain in place until they can be removed without endangering the stability of the plant.

Temporary bracing and attachments shall be fixed and removed in such a way as to prevent damage occurring to the base metal to which they are attached. Projecting welds remaining after this operation shall be ground flush. Tears in the base metal shall be filled with weld and ground flush. After completion of work, the surface shall be restored to proper condition by grinding and repainting.

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Welding, torch-cutting and drilling work on the plant to be erected shall only be carried out with the approval of the Engineer.

8.3.5 General Notes on Workmanship

Special care shall be taken not to damage surfaces of galvanized or specially treated plant during erection. Care shall be taken to prevent or remove any rust streaks or foreign matters deposited on galvanized or otherwise finished surfaces during storage or transport or after installation.

Glass parts of other parts which can easily be damaged shall be provided with suitable protective sheaths or coverings during installation.

Machined or bare metal surfaces that are not painted shall be protected during transportation, storage and erection by a suitable anti-corrosion film.

All portable power tools shall preferably be operated pneumatically.

Special tools which are supplied for maintenance and repair can be used for installation. They are to be handed over at the end of the installation work in good condition in accordance with the Engineer's instruction.

After erection, the works shall be finally painted; it shall be done as far as applicable in accordance with the painting specification, and any damaged paint-work be restored.

8.3.6 Modifications, Rectifications and Re-Erection

If the dismantling, modifications, rectification, addition etc. is necessitated due to any mismatch/discrepancy in the fabrication drawing prepared by the Contractor or in fabrication, the Contractor shall be held responsible for the same despite the fact that such drawing might have been approved by the Engineer. In such cases, nothing extra shall be payable to the Contractor towards carrying out such modification, rectification, addition, dismantling testing, transportation and any other allied activity.

In case, it is found that certain erection marks as already detailed and approved in fabrication drawings require addition, alternation and modification, the same shall be done on the written orders of the Corporation or his authorised representative.

The work of re-erection include carriage of modified erection marked members from fabrication shop to erection site, lifting of the same to the required position, aligning, erection in position inclusive of bolts and touch up pointing etc. complete to the satisfaction of the Corporation.

The quoted price shall include all these operation.

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8.3.7 Foundation Bolts

Foundation bolts for bus structure and elsewhere shall be embedded in first stage concrete while foundations cast. The bolts may be provided in pipe sleeves permitting adjustments in the proper alignment of these bolts to match holes in the structure basis. The final adjustment of these bolts and their grouting and provision of shiner for correct erection of structure is to be included in the unit rate of items of structural steel.

The Contractor shall be responsible for the correct alignment and levelling of all steel works on Site to ensure that the columns/towers and structures are plumb.

Before erection of columns/towers/structures on the foundations, the top surface of base concrete shall be thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material and shall be chipped with chisel to ensure proper bond between the ground and foundation concrete. The Contractor shall also be responsible for bringing the top of concrete to the desired level by chipping. In case foundation as cast in lower than the desired level. The Contractor shall make up the difference by providing additional pack plates and shims without any extra payment for any such work or materials.

No steel structures shall be put on foundation unless such foundations have been certified fit for erection of steel by the Corporation. Adequate number of air release holes and inspection holes shall provided in the base plate.

Foundation bolts for the structures shall be supplied by the Contractor.

9 INSPECTION AND TESTS

9.1 General

In addition to the provisions established in the Conditions of Contract (Volume I, Section III) regarding general procedure of inspections and tests, terms and definitions, and time schedules for inspections and tests the following stipulations shall apply.

Engineer reserves the right to ask for the valid calibration certificate for any instrument to be used for testing or may get the instrument tested by any independent agency.

9.2 Type Tests / Routine Tests / Acceptance Tests / Site Tests

For the specified type tests certificates for the same equipment type, not older than ten years from the date of signing the Contract, shall be submitted for approval by the Corporation. In case that the test certificates are older than ten years the Contractor shall carry out the specified type tests at his own costs.

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Contractor shall have to do all the routine tests, acceptance tests & site tests required as per technical specification & Indian Standards / International Standards.

Contractor shall have the access to the required facilities as stated in the relevant standards to carryout the tests on the various equipment.

In case, contractor does not have the facility to carryout any of the test and intends to carryout the same at some other agency those testing agencies shall be got approved by the engineer.

9.3 Workshop Inspections and Tests

As far as practicable, quality of materials, workmanship and performance of all items of the work and plant to be furnished under this Contract shall be inspected at the places of manufacture.

When placing orders for material and plant with Sub-suppliers, the Contractor shall send unpriced copies of such orders in triplicate to the Engineer.

Where the Contractor desires to use stock material, not manufactured specifically for the work, satisfactory evidence that such material conforms to the requirements of the Contract shall be submitted. Tests on these materials can be waived.

Arrangements shall be made for expediting the shop inspection by having all shop assemblies or pieces covering a single shipment ready at one time. Any painting work as well as transport to the Site of the plant shall not be started before the approval of the Engineer has been obtained.

9.3.1 Material Tests

Unless otherwise specified, the quality of materials shall be verified generally by:

chemical analysis	
mechanical tests	(yield point, tensile strength, elongations, notch impact strength, etc.)
welding tests	(welding procedure, welding material, welding tensile strength, welding bend test, welding reversed bend test, etc.)
non-destructive tests	(x-rays, ultrasonic, magnaflux, liquid penetration inspection, etc.)
electrical tests	(voltage, losses, tan delta, insulation, magnetic properties, etc.).

Certified mill test reports of plates will be acceptable when these comply with the requirement for "Reports of Inspections and Tests" as stated in the Special

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Conditions (Volume 1 Section II). Test specimen and samples for analysis shall be plainly marked to indicated the materials they represent.

Castings and forgings shall be tested in the rough state in order to detect flaws in good time thus avoiding delays. Magnetic particle inspection of important castings shall over the whole surface of the casting. After partial machining further tests can be conducted.

Load tests on crane hooks, steel wire ropes, chains, etc. shall be considered as material tests.

9.3.2 Checking of Dimensions

The dimensions, especially clearances and fits, (ISO 286) which are essential for operation and efficiency shall be carefully checked in an approved manner, as for example:

- runout and roundness tolerances of shafts. Rotors, pistons, etc., to be measured on single parts as well as (wherever possible) on the assembled components
- fits and clearances of bearings, runners, rotors, servomotor pistons, valves, guiding, distributing and actual actuating elements, etc.
- accuracy, surface roughness and shape of sliding and guiding surfaces of seals, bearings, water passages in hydraulic machinery, valves, etc.
- profiles of turbine runners, pump impellers, etc. to be checked by means of templates
- dimensions of couplings or connections for assembly with other deliveries from the Contractor, Sub-contractors or other contractors.

9.3.3 Shop Assembly

In addition to the quality and production control tests, the following shop assembly work and tests shall be made to check measurements, fitting and functioning.

Plant to be furnished shall be shop assembled to a status sufficient to prove that the design and workmanship have been executed in accordance with the Specifications, that the delivery is complete, and that no work remains to be done at Site which reasonably can or should be done in the shop.

Where applicable, each item of the plant shall be assembled completely prior to painting.

Field joints shall be temporarily connected.

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All parts shall be properly match marked, identified and doweled where practicable, to facilitate correct and quick field assembly and alignment. Wherever necessary, suitable dowels shall be provided for insertion after field assembly and drilling. The holes for any fitted bolt shall be accurately reamed.

During shop assembly all instruments, control devices and piping shall be fitted.

If the corrections cannot be carried out in accordance with the terms mentioned above, the components concerned will be rejected. The decision on possible subsequent corrections is reserved exclusively to the Engineer. Faulty parts or plant shall by no means be delivered.

The assembled parts shall subsequently be subjected to tests as per applicable standards of required by the Engineer.

9.3.4 Pressure and Leakage Tests

All parts subject to internal or external pressure or containing any liquids or gases temporarily or permanently during operation shall be tested prior to painting. As far as practicable, these tests shall be done in the shop but can be repeated at Site.

Parts exposed during operation to hydraulic pressure, to gas pressure or to any liquid without pressure, shall be treated distinctively.

In addition to the Specifications, the applicable and approved standards and official regulations shall be observed. If any liquid is used for the test that may cause corrosion, all plant and piping shall be thoroughly cleaned immediately after the test.

As far as practicable and required, the influences of temperatures and temperature differences to which the part will be exposed during operation shall be considered in the execution of the tests.

Leaks and defects can be repaired if permitted by the applicable standard and approved by the Engineer. If defects are found, the Engineer may reject the defective parts, or permit welding repairs with stress relieving, radiographic examination and additional pressure tests.

9.3.4.1 Parts Exposed to Hydraulic Pressure

Unless otherwise specified or required, the following shall apply: the hydraulic pressure tests shall be carried out using the liquid to be used during operation or a liquid with less viscosity.

The hydraulic test pressure shall be 1.5 times the maximum operating pressure and shall be maintained for a period of two hours or longer if required by the applicable standards. Afterwards the test pressure shall be reduced to the operating pressure.

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The welded seams of large parts which are not subjected to any heat treatment during or after welding, shall be rapped with a 500 g hammer during the pressure decrease or treated other wise to obtain the required effect of stress relief.

Finally, the test pressure mentioned above shall be maintained for ten (10) minutes. Leakages appearing at seals, joints, etc. shall be measured and stated in the test report, together with the relevant pressures.

9.3.4.2 Parts Exposed to Gas Pressure

Parts which will be subjected to gas pressure during operation for example the turbine governor pressure tanks, pressure air tanks and others, shall be inspected and tested according to the official regulations with respect to design, construction, fittings, etc.

The pressure test shall be executed by applying the test pressure in accordance with the relevant standards and specifications.

9.3.4.3 Parts Exposed to Liquids without Over-Pressure

Parts which shall not be closed and which are exposed to only small pressures of any liquid during operation e.g. bearing housings, oil containers, etc. shall be subjected to a tightness test with a suitable liquid of low viscosity. The testing-period shall not be less than 10 hours, unless otherwise agreed.

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9.3.5 Functional Tests

Functional tests shall be defined as tests of the function of assemblies, subassemblies or parts of the plant under no load conditions. Functional tests shall be performed on all plant prior to the execution of operational tests.

9.3.6 Operational Tests

As far as practicable operational test shall be carried out on all plant, simulating operating conditions.

Parts to be delivered by sub-suppliers shall be tested either at the premises of the sub-supplier or of the Contractor, as agreed by the Engineer.

Before testing the Contractor shall submit a notice containing full information on the tests with detailed tables or graphs on the latest edition of the characteristic values of the plant to be tested and on the test facilities and equipment.

Testing of the electrical plant shall be performed in accordance with applicable Standards; they shall include but not be limited to tests for heating, loading, overloading, losses.

Operational tests of lifting equipment and other machinery shall include tests under nominal load and 125% of nominal load unless otherwise specified.

9.3.7 Electrical Tests

Electrical plant shall be tested in accordance with applicable Standards and agreed test programs and procedures.

9.3.8 Model Tests

Model tests for certain parts of the work or plant shall be carried out as specified.

9.3.9 Test Reports

Contractor shall have to furnish all the test reports of tests performed on materials, equipment & plants etc. during various stages such as manufacturing, shop assembly etc.

9.4 Site Inspection and Tests

During erection, commissioning and Test Service Period operation the Contractor shall perform at suitable interval all inspections and tests in the presence of the Engineer in order to prove the orderly execution of the works in accordance with the Contract.

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Unless otherwise specified, all costs for testing at Site and of the works and charges associated with it shall be born by the Contractor. This includes the measuring devices, properly calibrated, and any pertinent accessories, which shall be made available by the Contractor for the entire duration of the tests. The Contractor shall delegate his experts to perform the tests at site.

For the procedure of inspections and test at Site, notice to the Engineer, reports, commissioning trial runs and acceptance tests refer to General Conditions (Volume I, Section III).

9.4.1 Commissioning and Test Service Period

Immediately upon completion of commissioning of a part or section of the Plant which can operate as an independent unit a “Certificate of Suitability for Operation” shall be issued by the Engineer.

This document shall be signed by an authorized representative of the Corporation, the Engineer and the Contractor. On completion of Test Service Period this certificate becomes null and void.

This Certificate shall state:

- the supplier of the plant concerned
- the quantity and type of plant concerned
- the conditions of commissioning
- the names of the participants
- the date of commencement of Test Service Period
- the list of minor defects, if any.

During the operation in Test Service Periods the Contractor shall make familiar the Corporation’s personnel with the properties, the operation and maintenance of the plant and its auxiliaries to such extent that thereafter the duties can be assigned to the Corporation’s trained personnel.

If any defects of irregularities affecting the safety or reliability of the plant, should arise during the Test Service Period, the Test Service Period shall be interrupted and started again after such defects or irregularities have been corrected by the Contractor.

9.4.2 Acceptance

The testing of any part of section of the Plant which can operate as an independent unit, shall be performed in accordance with the standards and regulations laid down

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in the “Particular Technical Specifications” and following the test procedure agreed upon between Engineer and Contractor.

Immediately upon completion of any such testing of a part of section of the permanent Plant a “Protocol of Acceptance” which shall be deemed to be the Test Certificate required by Conditions of Contract (Volume I Section III) shall be issued by the Engineer.

This document shall be signed by an authorized representative of the Corporation, the Engineer and the Contractor and shall form an integral part of the later “Taking-Over Certificate”.

This “Certificate” shall state:

- the date of testing
- the quantity and type of plant concerned
- statement of all minor defects and/or irregularities, which have to be corrected by the Contractor
- confirmation that the guaranteed data have been proven
- confirmation that all contractual documents have been submitted
- confirmation that the Corporation’s personnel has been familiarized with the plant and that they will be able to operate and maintain the plant.

If any test for the verification of the guaranteed data could not be performed for operational reasons beyond the Contractor’s responsibility, this part of the acceptance shall be stated in the “Certificate” and be postponed for a mutually agreed period.

9.4.3 Statutory Requirements

All statutory requirements as per provisions of the latest Grid Regulations prevailing at the time of commissioning of the units shall have to be fulfilled by the contractor.

10 CIVIL SITE WORK

10.1 Scope of Work of the Civil Works Contractor

The following works shall be carried out as part of the civil works contract covered under civil Package and is not included within the scope of work covered by this Package :

- All concrete work, including reinforcement and formwork, and all grouting required for filling in, around and under the various parts of the works to be embedded in concrete.

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- All necessary excavation and backfilling required for installing the plant in its final position, unless otherwise stated in the Particular Technical Specifications.
- Building in of all required parts into the first stage concrete. The readiness of such parts shall be communicated to the Engineer and they shall be delivered in due time by the Contractor unless otherwise specified or agreed in the Contract.
- Providing and grouting the block outs for all anchoring and foundation bolts needed to support and fix the plant in its final positions.
- All protective measures. e.g. pumping, etc. to keep the various parts of the plant and the erection site free from accumulated water during the time of erection.
- Provision of cable and ducts, trenches, block-outs, etc., in accordance with the drawings supplied by the Contractor and approved by the Engineer.
- Adequate safety covers and protective measures against injury or damage to the Contractor's employees and equipment and to the works due to any operations of the civil contractor.
- Piping, fittings etc. required for Power House Surface drainage (through gravity) upto the drainage sump.

If chequered plates or other covers provided under the civil contract require special care for fitting to plant and installations, such work (Cutting, Matching, Welding of supports, etc.) shall be performed by the Civil Contractor.

In addition to the above, the civil works for the following items shall also be carried out by the Civil Contractor as per drawings furnished by the Contractor of this Package and approved by the Engineer of NEEPCO.

- a) Cable trench between Powerhouse and Pothead yard
- b) Cable trenches along with covers and cable trenches crossing roads/rail track as per the drawing
- c) Drainage pit
- d) Foundations for lighting materials
- e) Civil works required for foundation & fire protection works of Generator transformers/ Station Service transformers
- f) Drainage System
- g) Roads in the plant
- h) Other requirements

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10.2 Checking of Equipment after Grouting

The Contractor shall check and verify the levelling and alignment of machinery as applicable before and after grout is done and to ensure that no displacement had taken place during grouting. Required arrangement to accomplish the correct alignment shall be the responsibility of the this Package tenderer. The values recorded prior to grouting shall be used during such post grouting check-up and verifications. The Contractor shall maintain such pre and post grout records of alignment details, in a manner acceptable to the Engineer.