

SECTION – III

GENERAL TECHNICAL SPECIFICATIONS

3.1 INTRODUCTION

The Contractor shall strictly observe these General Technical Specifications in conjunction with the Particular Technical Specifications. He shall carry out all work in a skilled and workman like manner in compliance with modern methods of engineering. All design, calculations, materials, works; manufacture and testing shall conform to the latest applicable standards.

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

3.2 SCOPE OF WORK

The scope of work would generally include detailed Engineering designs and drawings of the E&M equipments including machine foundations, supply of E&M equipments as per schedule, erection thereof and successful commissioning of the E&M components complete to generate 250 KW of power (2 X 125 KW). All the E & M components shall be from reputed manufacturers/company.

The scope of work in this Contract is established in the Particular Technical Specifications. The Contractor shall design, manufacture, supply, erect, test & commission, and hand-over to Owner and guarantee after commissioning and all works complete in every respect with all necessary accessories in conformity with civil contractor for reliable continuous operation as per the detailed technical specifications. The power house should be able to operate in isolation as well as in synchronisation with the Grid.

These Specifications include the performance of all works and the provision of all labours, materials, permanent and temporary equipment, tools, accessories for transport to the site, including loading, unloading, if necessary reloading in the port of arrival, complete installation, painting, testing and commissioning of all works and accessories of the works.

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

3.3 PROJECT DETAILS AND SALIENT FEATURES

3.3.1 Project Details

3.3.1.1 Location

The project area is located in the hills of North Eastern region (Arunachal Pradesh) of the country.

Ayingmuri MHS is located on the Gyo Nallah near Ayingmuri Village. The Ayingmuri Village is well connected by road to Daporijo via Ziro of Lower Subansiri District.

The design discharge for feeder channel is taken as 1.21 cumecs. The design discharge in feeder channel is kept 15 % higher than that of head race channel as extra discharge is required for silt flushing in desilting tank.

3.3.1.9 Maximum Flood

The hydraulic structures have been designed to withstand the flood discharge. Their location etc. have also been fixed in a manner that the same do not submerge during floods.

3.3.1.10 Land Rights

The land required for Ayingmuri micro hydel project belongs to state Government. The land requirement is quite small and it will be transferred from the Government to DHPD. Land rights are to be got transferred by DHPD before the actual construction work is taken up.

3.3.1.11 Water Rights

The water used in hydro electric plant is non-consumptive. The scheme utilizes the water of the river Gyo Nallah which will be discharged back into the river after power generation. Since it is non-consumptive use of water, therefore there shall be no objection of utilizing it for hydro generation by State Govt. and shall be available free of charge.

3.3.1.12 Water Quality

The quality of water is considered suitable for construction purpose and but for turbine runner material the water quality will be improved by providing desilting tank as it is affected a lot during monsoon variance in water quality. The bed and suspended silt load studies are proposed to be carried out during detailed design of the project for proper and cost effective design of desilting arrangement. During monsoon the water carries silt but that is to be adequately taken into consideration for effective civil works design.

3.3.1.14 Powerhouse

The main features of powerhouse shall be as follows:

- Two Nos. Turbine with Synchronous Horizontal Generators each of 160 KVA 0.415 kV 0.8 PF rating.
- Surface powerhouse of size 10 x 6 x 8 m for accommodating horizontal turbine generator set, auxiliaries, switchgears, Battery set.
- Tail race channel 20 m long confluence with the main river in down stream of power house. A deck slab SLR bridge on Tail Race Channel D/S of powerhouse.
- An open 11 kV switch yard by the side of the power house main building. The power station will be connected to the nearest 11 kV substation.

The project will be a self contained, providing necessary basic facilities to the personnel working during construction and subsequent operation and maintenance.

3.3.2 Salient Features

1. LOCATION

a.	State	:	Arunachal Pradesh
b.	District	:	Upper Subansiri
c.	Village	:	Ayingmuri
	Access	:	
	Road	:	98 km from Daporijo to project site 160 Km from Daporijo to Ziro 115 Km from Ziro to North Lakhimpur
	Air	:	Tezpur – 200 kms from NLP
	Rail head	:	North Lakhimpur NF Railway

2 HYDROLOGY

a.	Name of River	:	Gyo Nallah
b.	Type of river	:	Perennial
c.	Discharge	:	2.64 cumecs

3. DIVERSION WEIR

a)	Type	:	Trench weir
b)	Shape	:	Trapezoidal
c)	Length	:	20 m
d)	Design discharge	:	1.37 cumecs

4. INTAKE CHANNEL

a)	Length	:	100 m
b)	Shape	:	Rectangular
c)	Size	:	Width – 1.10 m Depth – 0.85 m

- d) Bed slope : 1 in 200
- e) Full supply depth : 0.55 m
- f) Free board : 0.30 m

5 DESILTING TANK

- a) Total length : 24.00 m
- b) U/S Transition Length : 3.00 m
- c) D/S Transition length : 4.00 m
- d) Width : 6.00 m
- e) Type : R.C.C.
- f) Design discharge : 1.21 cumecs
- g) Full supply depth : 2.00 m
- h) Total depth : 2.60m
- i) Free board : 0.30 m

6. POWER CHANNEL

- a) Length : 420 mtrs.
- b) Shape : Rectangular
- c) Size : Width – 1.10 m
Height – 0.85 m
- d) Bed slope : 1 in 200
- e) Full supply depth : 0.55 m
- f) Free board : 0.30 m

7. FOREBAY TANK

- a) Size : 7.75 m x 6.00 m
- b) Total Depth : 2.80 m
- c) Type : RCC
- d) Full supply depth : 2.50 m
- e) Material : R.C.C.
- f) Silt storage : 0.20 m

- g) Free board : 0.30 m
- h) Water over Spillway during machine shut down : 0.15 m
- i) Spillway length : 3.50 m
- j) Spillway Channel length : 25.00 m

8. PENSTOCK

- a) Number : 1 no.
- b) Diameter : 700 mm (O.D.)
- c) Thickness : 6.00 mm
- d) Material : Spirally welded steel pipes
- e) Length : 160.00 m
- f) Design discharge : 1.05 cumecs

9. POWER HOUSE

- a) Type : S.P Type construction with Brick wall with C.G.I. sheet roofing.
- b) Size : 10.00 m x 6.00 m
- c) Capacity : 2 x 125 kw
- d) Gross head : 33.66 m
- e) Net head : 31.00 m

10. ELECTROMECHANICAL EQUIPMENT

a) Turbine

- i) Type : Horizontal francis
- ii) Number : 2 nos.
- iii) Capacity of each turbine : 125 kw

b) Generator

- i) Type of generator : Synchronous
- ii) Number : 2 nos.

11. TAIL RACE

- a) Shape : Rectangular
- b) Size : Width – 1.10 m
Depth – 0.85 m
- c) Length : 20 m (approx.)

12. APPROACH ROAD

- a. Total length : 98.00 km (from Daporijo)
- b. Road width : Truck able standard

13. SWITCHYARD

- a. Voltage level/basic insulation level : 0.415/11kV
- b. Step-up Transformer : 315 kVA, 0.415 / 11 kV

3.4 CONSTRUCTION PROGRAMME

The project is envisaged to be completed within 8 months from the date of awarding contract.

The contractor has to take into account the factors necessary to be considered for design, drawing, layout construction/execution, supply of electrical/mechanical equipment, erection and commissioning of E&M equipment complete system for generating specified power and evacuate the same to grid.

3.4.1 Project Drawings

The work shall conform to the proposed drawings of the Project all of which form a part of these specifications. The final design of the power plant will be modified in so far as practicable to suit the equipment furnished and layout plans recommended by the Bidder

3.4.2 Control Of Unit Operation

The power House is proposed to be controlled automatically. Provision is also to be made for emergency manual control.

3.5 STANDARDS

When the Standards are referred to, the Edition shall be the current at the time of issue of Tender Documents, together with any Amendments issued to that date.

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If requested by the Engineer, the Contractor shall supply at his own expense two copies in English of any national standards, which are applicable to the Contract.

Standard publications issued by the different organisations of standardisation are considered being approved standards for the works and are listed in Table A of this section:

3.6 TECHNICAL SPECIFICATIONS

3.6.1 General

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

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 at the site. The Contractor shall not be released of his responsibility and guarantee after drawings and computations have been approved by the Engineer.

3.6.2 Drawings

Preparation of all designs and drawings in respect of the project shall be the entire responsibility of the contractor.

All the drawings shall be worked out on computers using latest version of AutoCAD on maximum A1 size. All electrical drawings including schematic drawings, block diagrams, flow diagrams, terminal details, panel outline drawings, circuit diagrams etc. shall be worked out on A3 size. All drawings shall have a uniform title-block as approved by the Engineer. Beginning with the very first submittal to the Engineer, the Contractor's drawings shall bear a serial number corresponding to a drawing classification plan to be agreed upon by the Contractor and the Engineer. The drawings of bought out items shall also be preferred in AutoCAD version, however, their scanned version will be allowed. 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 works concerned are clearly marked. These documents also shall be scanned and stored on CD.

Five sets of hard copies of the drawings shall be submitted to the Engineer for comments / approval by the consultant to be engaged by the purchaser prior to executing the work. The comments shall be marked on one set of hard copy and returned to Contractor for necessary correction in original drawings. Corrected drawings replacing previously submitted drawings should be marked accordingly. The final approved drawings shall be submitted on CD with eight sets of hard copies in product wise folders.

If the Engineer feels it necessary to give any comment on a drawing submitted “For Information Only”, the same shall be entertained by the Contractor as “Drawing for Approval”.

If any revision is required in the approved drawings by Contractor or the engineer, the same shall be got approved again and revised drawing shall bear revision number.

Drawings in respect of the following shall be supplied:

i) Foundation Drawings

If a piece of Works 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. The drawings shall clearly indicate the embedments and 1st, 2nd, 3rd stage C.C. lines.

In addition, they shall include openings, sleeves, and details of conduits, drainage and dewatering system slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

ii) Arrangement and Layout Drawings

All arrangement and layout drawings shall be drawn to scale. The General Arrangement Drawings shall show the physical arrangement of Works embedments and equipment and their layout in the Power House, switchyard and appurtenances.

iii) Assembly and sub-Assembly Drawings

The assembly drawings shall show all elements and the main dimensions of individual components and embedments in plan view, cross-section, side and top views. The **assembly** drawings shall include erection drawings, piping diagrams and piping arrangement drawings, etc., showing the dimensions, design and data of all constructions, apparatus and Works to be furnished under this Contract.

These drawings shall show:

Assembly of the Works in plan, elevation and detail views with main dimensions Sub-assembly of the principal components of the Works which shall require dismantling, assembly and adjustments at site for maintenance, giving overall dimensions, adjustment, clearances and fitting tolerances

Sub-assemblies in which the Contractor proposes to ship the Works

Instructions for heat treatment, pressure tests, surface preparation and anti-corrosive 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.

iv) Schematic Diagrams

Schematic diagrams of turbine control and auxiliary systems like oil pressure unit, compressed air system, drainage / dewatering system, cooling water system, inlet valve etc. are to be supplied. These drawings shall show all instruments and control devices. Standard abbreviations and component numbers shall be used as per relevant standards.

v) Single-Line Diagrams

Each electrical works and their circuits shall be represented by a single line diagram. It shall contain all required technical information of the Works represented, e.g. voltage, current, capacity, short-circuit level, ratios, voltage variations, measuring transformer and protection relay indices, interlocking, kind of switch drive, code designation, etc. as applicable.

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

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

vi) 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, Works 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 Works or forming part of the Works or control devices shall appear between these two lines.

Contact 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.

Circuit diagrams shall also contain all terminals and their correct designations. Terminals grouped together to terminal blocks of switchboards, distributors, etc.

The representation of electrical works 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 Works to be supplied by others shall be taken over as well.

vii) 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. servomotors, computing modules, etc., shall clearly be explained on the diagram or on an attached legend.

viii) Terminal Diagrams

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

3.6.3 Lists and Schedules

Following lists and schedules shall be supplied:

i) Cable Lists / Interconnection Lists

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

- Cable number, in accordance with Identification System.
- Cable type
- Rated voltage
- Number material and size of conductors
- Overall diameter
- Cable termination at each end
- Connection point at each end with cubicle/Works identification and terminal numbers
- Cable routing

In case interconnecting cubicles are used, the lists shall be prepared to show:

- Cable termination for incoming and out coming cables
- Interconnection wiring

ii) Alarm Lists

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

- Description and denomination of alarm

- Data of alarm detector (contact) referring to applicable circuit diagram
- Data of alarm annunciator (location and clear text labelling)

iii) **List of Final Control Elements**

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

- Data of pipe and valve connections
- Data of valve layout
- Maximal required and rated power

3.6.4 Calculations

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, stress levels, dimensions and operational characteristics, safety factors, clearly indicating the principles on which the calculations were based. The calculations shall include the formulae, standards, test results, basic assumptions, etc. Submission of computer calculations without baseline information such as derivation of the calculation method, applied formulas, definition of variables and constants, explanation of abbreviations etc., will not be accepted.

Short-Circuit Calculations

The short-circuit calculations shall be performed in accordance with VDE Standard 0102, part I / IEEE 242 and 399.

3.6.5 Operation and Maintenance Manuals

The Operation and Maintenance Manuals shall be prepared in latest version of MS Word with enclosures in the form of computerised drawings and scanned figures. They shall be supplied on CD along with Ten (10) hard copies in properly bound form. The O & M manuals shall contain the following information in sufficient detail to enable the Purchaser to maintain, dismantle, reassemble, adjust and operate the Works with all its items of Works and installations:

- (a) Table of Contents
- (b) List of Illustrations
- (c) Introduction
- d) Detailed Description

Detailed description shall contain a complete and accurate description of the Works, all components and ancillaries, their assembling and dismantling. An accurate list stating clearances, tolerances, temperatures, fits, etc. shall be included.

- (e) Operating Principles and Characteristics

A brief summary of the technical operating principles of the Works, including diagrams, circuit diagrams, sequence diagrams, piping, etc.

Operating Instructions

The instructions shall contain the sequence of individual manipulations required for operation. Tables, lists and graphic presentations should be used whenever possible for making the description readily understandable. An appropriate trouble-shooting list shall be included in this chapter.

Testing and Adjustment

The entire testing and adjustment procedure required for the Works after overhauls and during operation shall be described.

h) Maintenance Instructions

This section is divided into five paragraphs:

h1) Preventive maintenance, indicating the inspections required at regular intervals, the routine cleaning and lubricating operations, the regular safety checks and similar steps.

The maintenance instructions shall include a tabular summary of the required activities sorted according to

Daily

Weekly

Monthly

Quarterly

Yearly

(Or other) cycles as applicable.

h2) Repair and adjustment procedures including fault tracing

h3) Spare part lists, containing all the necessary data for ordering spare parts. These lists shall include all spare parts, those to be supplied and those not to be supplied under the present Contract. *Detailed drawing for each item of spare parts shall be supplied.* The above list should include minimum and maximum quantities of spares to be maintained by the project.

h4) Tool lists, containing all necessary data for identification of tools to be delivered under the present Contract.

h5) List of Contractors of bought out items and their addresses.

H6) As-built drawings

3.6.6 Installation and Commissioning Manuals

The Manuals of Installation and Commissioning Procedures shall be prepared in latest version of MS Word with enclosures in the form of computerised drawings and scanned figures. They shall be supplied on CD along with 10 (Ten) hard copies in properly bound form. These manuals shall contain the following information in detail:

Installation Procedures

The installations procedures shall describe in sequential steps the erection of major equipment and shall contain sufficient details such as equipment preparation on erection bay, handling of large and heavy pieces, levelling, anchoring, site welding, site painting, erection checks, site pressure tests, site flushing and cleaning of hydraulic systems, alignment and run out checks to allow the Engineer / Purchaser to plan and supervise the Works at site, if required. The manuals shall contain the Log Sheets for taking measurements during installation.

Pre-Commissioning Tests and Procedures

Pre-commissioning tests and procedures shall be described in sequential steps for the pre-commissioning of all electrical and mechanical equipments and shall also contain sufficient details viz. checking of installations, ratings, cable terminal checking and operation test of all auxiliary equipments etc. necessary Log Sheets shall be annexed to facilitate proper recording of test results.

Commissioning Procedures

The commissioning procedures shall sequentially and in sufficient detail describe activities and tests for all systems covered by the Contract Document.

3.6.7 Progress Reports during Design and Manufacturing

During design and manufacturing the Contractor shall monthly submit four (4) copies of the progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding period. The report shall contain (but 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 design and manufacturing 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 quarter with reference versus the scheduled programme. Appropriate comments 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.

3.6.8 Progress Reports during Installation at Site

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During erection the Contractor shall, submit four (4) copies of the fortnightly progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding month. The report shall contain (but 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 fortnight with reference versus the scheduled programme. Appropriate comments 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.
- Progress photographs of significant events. The Engineer may direct the inclusion of specific photographs if deemed necessary.
- A statement detailing the status of progress on the overall programme and how to regain any lost time or setbacks 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.

Quality Assurance Plan For Manufacturing Works

Four copies of Quality Assurance Plan giving details of inspection, tests and customer witness / hold points shall be submitted with the bids. The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. The tests will include material composition and its properties, NDT, X-ray, hydraulic tests, leakage tests, insulation, high voltage tests and functional tests etc. along with the applicable standards and acceptance criteria.

The Contractor shall get the quality plans finalised and approved after the award of the Contract. The approved quality plan shall form the basis for inspection and acceptance of the equipment. The Engineer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval due to non availability of final design drawings.

Quality Assurance Plan for Site Installation & Commissioning

Four copies of Quality Assurance Plan giving details of stage inspection during installation, pre-commissioning and commissioning tests and customer witness / hold points shall be submitted with the bids.

The quality plan shall contain the details of inspection and tests to be carried out for each major component of each functional assembly as recommended by the manufacturer as per their standard practice. Test Procedure shall be specified giving for each test item (kind of test) a description, test method / standards, used instruments, sample/routine test, test judgement.

The tests will necessarily include NDT, X-ray, hydraulic tests, leakage tests, insulation, high voltage tests and functional tests etc. along with the applicable standards and acceptance criteria.

The Contractor shall get the quality plans finalised and approved after the award of the Contract. The approved quality plan shall form the basis for inspection and acceptance of the equipment at site. The Engineer shall have the right to ask for more relevant tests if the same could not be included in the quality assurance plan at the time of their approval due to oversight and/or non availability of final design drawings.

3.7 SPARE PARTS, TOOLS AND SITE CONSUMABLES

3.7.1 Spare Parts

All spare parts to be supplied shall be interchangeable with the corresponding parts of all the Works supplied under these Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components.

All spare parts shall be protected against corrosion and shall be marked with identification labels. The identification scheme for spares shall be sent for Purchaser's approval before dispatch of any spare.

All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage.

Spare parts supplied under this contract shall not be given to the Contractor for use during erection and commissioning for replacing the defective or damaged original components of his supplies of works. The Contractor will arrange the spares required during the erection and guarantee period at his own.

The required list of spare parts has been given in Technical Specifications of respective equipment/works. The Bidders will give a separate list of spares recommend by them in addition to the list given in particular specifications and offer the price of the same separately in schedule of prices for spares. Wherever the quantity of spares is given as set/sets, it will be taken as quantity for both generating units. Sufficient quantity of spares will be included for parts which are more prone to frequent wear and tear and can be replaced easily without involving long shutdown.

The Contractor shall provide 5%, but at least two pieces of all types of bolts, screws, nuts, washers, spanner rings and cotters. The quantity may be taken from the surplus handed over to the Purchaser after completion of the installation as described under the chapter "Bolts, Screws, Nuts, etc." of this Section.

Orders for recommended spare parts shall be optional to purchase by the Purchaser for a period of one (1) year after the date of the completion of the project.

3.7.2 Tools and Appliances

The scope of work shall include all customary and special tools, as well as auxiliary devices including lifting devices, ropes, etc. necessary for total assembly and disassembly of all parts of the supplied Works. Furthermore, all accessories for maintenance shall be supplied and included in the Tender. The total price for tools and devices as required by this article shall be included in the Total Tender Price. The special lifting devices and tools designed and supplied for the project, can be used by the Contractor during erection and will be handed over to Purchaser in good working condition without any wear and tear. However, ropes, slings, small hoists and winches etc. shall be handed over in new condition.

All lifting devices and wire ropes slings to be used at site shall be tested at works and test certificate shall be supplied to the Engineer.

Suitable toolboxes shall also be included in the delivery. An itemised list and description of all provided tools, auxiliary devices, etc. shall be included in the Tender. The Purchaser shall be entitled to take over from the Contractor the entire erection tools, appliances, instruments at mutually agreed conditions.

The scope of work shall include 4 (Four) number Pentium-IV, computer sets each with CD drive and multi-media facility, 19" colour monitor, suitable UPS, external modems, A3 size laser printer and A1 size plotter.

3.7.3 Site Consumables, Lubricating Oil and Grease for First Filling

Scope of work shall include all site consumables like welding electrodes, brazing materials, insulating materials, sealants, cleaning agents, paints and varnishes, grinding wheels/discs, fasteners and raw materials etc. in fairly sufficient quantity so that erection and commissioning activity is not held up for want of these items.

For all items under this Contract, the Contractor shall deliver 5 % of the quantity of painting material, but at least one litre, in new sealed containers, for later repair works other than the Contractor's.

Lubricating oils, insulating oils and greases etc. required for first filling in the plant and equipment supplied by the Contractor under this Contract shall be supplied in quantity 20 % (twenty percent) higher than the actual capacity for first filling. These items shall be supplied as per site requirement and shall not be stocked with main equipment.

3.8 DESIGN REQUIREMENTS

3.8.1 GENERAL

The equipment shall be designed and manufactured to provide most optimum functional value and neat appearance. All major assemblies or equipment shall be designed to facilitate easy and quick surveillance, maintenance and optimum operation. All control sequences shall be simple and rational.

All live, moving and rotating parts shall be adequately secured in order to avoid danger to the operating staff. All electrical components shall be electrically earthed.

Suitable lifting eyes and forcing off bolts shall be provided where required or where they will be useful for erection and dismantling.

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

Additional cost can only be accepted after mutual discussion; in case of a basic design the Engineer suggests change after award of Contract.

3.8.2 Design Responsibility

The contractor shall assume full responsibility for a coordinated and adequate design of all equipment specified and shall ensure that such equipment conforms to the best engineering practice for the operating conditions specified. When requested by the Engineer, the Contractor shall furnish complete information as to the maximum stress and other criteria used in the design.

Working Stress

Conservative factors of safety shall be used throughout the design and especially in the designs of all parts subject-alternating stresses of shock. For the rotating parts of the generator and exciters, the maximum units stresses due to runaway speed of turbine shall not exceed two –thirds of the yield point.

Maximum Unit Stresses in Kilogram Per square Centimeter

Material	Stress in Tension	Stresses in Compression
Cast Iron	140	700
Cast Steel	700	700

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Alloy Cast Steel	20 % of the ultimate Strength or 33 % of the yield point, whichever is less	20 % of the ultimate Strength or 33 % of the yield point, whichever is less
Plate Steel for Principal parts	840	840

For other materials used in the manufacture of the generator and exciter etc. the maximum stresses due to the most severe operating conditions shall not exceed one-third of the yield point nor one-fifth of the ultimate strength of the material. For temporary overloads, unit stresses not exceeding one-half the yield point stress will be permitted.

3.8.3.1 Steel Casting

Except otherwise specified herein, all steel castings shall conform to 'standard specification for Mild to Medium strength carbon steel casting' (A.S.T.M. Designation A27-46-T, grade 63-35, of the American Society for Testing Materials). Before proceeding with foundry **work**, The Bidder shall submit to the Purchaser, drawings of all important steel castings, showing thereon the location of tension and end test specimens. The Bidder shall notify the Purchaser in time to have an Inspector present at the foundry when casting have been cleaned and are ready for

surface inspection and before any repairs are made and after the castings have been annealed and before they are shipped to machine shop. No repairs shall be made to castings without the knowledge and approval of Purchaser. Welding shall be performed only by properly qualified welders and accordance with the best welding practice. Cracks and other defects disclosed when the casting are cleaned or during machining operations shall be chipped to sound clean metal before any repairs are made. If the removal of metal to uncover the crack or defect reduces the stresses resisting cross section of the casting more than 50 % or to such an extent that the computed unit stress in the remaining metal is more than 50 % in excess of the following stress, the casting may, at the option of the Purchaser Inspector be rejected. Casting requiring welding repairs impairing the strength of the stress-resisting cross section, at any stage of the manufacture after the first annealing, shall be reannealed, unless otherwise permitted by the purchaser. All thicknesses and or other dimensions of the casting shall not be less than called for on the drawings by an amount sufficient, in the opinion of the purchaser, to impair by more than 10 % the strength of casting of the dimensions shown on the drawings and to exceed the stresses allowed under these specifications. Casting shall not be warped or otherwise distorted, nor shall their dimensions be oversized to such an extent as to interfere with the proper fit with other parts of the apparatus. The structure of the casting shall be homogeneous and free from excessive nonmetallic inclusions. An excessive segregation of impurities or alloys at critical points in a casting will be cause for its rejection.

3.8.3.2 Steel Plates

Steel plates for all the principal stress-carrying parts shall be fire-box quality grade B, conforming to the 'Standard specifications for Low Tensile Strength Carbon-Steel plates of Flange and Fire box Qualities' (ASTM Designation: 185-49 T) of the American Society for Testing Materials or other recognized standards, steel plates for generating housing cover plates and other moderately stressed parts shall be fire box quality grade A or B, conforming to the above mentioned A.S.T.M. Specifications or other recognized standards. The material

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selected shall be suitable for the required service.

Maximum stress values shall not exceed the allowable values as given in Particular Technical Specifications or in the relevant standards and regulations and agreed by the Engineer. However, the Contractor shall be responsible for an adequate design using lower working stresses it deems this necessary or desirable.

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 and appropriate allowable stresses.

3.8.4 Seismic Loads

The forces being caused by earthquake including hydraulic loads, which may occur additionally, shall be taken into account for the computations.

The project lies on zone V of Seismic Zoning map and this zone correspond to seismic intensity IX of modified Marcella Scale.

Stresses resulting after including these loads shall not exceed permissible stresses and following provisions shall be made in the Generator, Turbine and all switchyard equipment structure.

3.8.4.1 Mechanical strength

Generator, turbine, switchyard equipment and structure be designed to safely withstand earthquake acceleration force 0.3g both in the vertical and horizontal direction.

3.8.4.2 Natural frequency

Natural frequency of the machine be kept well away (higher) from the magnetic frequency of 100 Hz (twice the generator frequency). The natural frequency must be much away from multiple of runner blades passing frequency.

3.8.4.3 Generator stator support and bearing brackets

Generator stator and bearing brackets of turbine and generator be designed to safely withstand horizontal and vertical forces due to earthquake.

3.8.4.4 Vibration detector

Vibration detectors or eccentricity meters on turbines and generators should be provided for alarm and shut down.

3.8.4.5 Mercury Contacts

Anti vibration type mercury switch be used.

3.8.5 Standardisation of Works

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Every effort shall be made to standardise parts, instruments and devices to minimise costs of the Works and facilitate keeping stocks, maintenance, replacement, interchange ability, etc.

3.8.6 Surface Finish

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.

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.

3.8.7 Fits and Tolerances

Fits and tolerances shall be given in accordance with ISO Standard. Tolerances on matching components shall be suitable for intended service and will ensure interchangeability. Fits shall be selected for the smooth functioning of the components for fairly long life.

3.8.8 Materials

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which equipment is to work. Tropical grade material should be used wherever possible. Material specifications, including grade or class shall be shown on drawings submitted to the Purchaser.

3.9 MANUFACTURING REQUIREMENTS

3.9.1 Workmanship

All works shall be performed and completed in highly professional manner and shall follow the best modern practices in the design and manufacturing of the equipment. All parts shall be made accurately and shall not deviate from drawing and quality requirements. Wherever, in process inspection is required, due notice shall be given to inspection agency and the inspection shall not be bypassed. The Contractor shall arrange all measuring instruments, gauges, templates, fixtures and devices required for the purpose. All special gauges, instruments and devices deemed necessary for the maintenance of the equipment, shall be offered and included in scope of supply under this contract.

3.9.2 Materials

All materials used, shall be new and of first class quality free from rust, defects and imperfections. Inspection documents of all materials shall be reviewed and compiled before actual use. The Engineer shall review the inspection records of materials of major components. Materials of limited shelf life shall not be used after their expiry date.

3.9.3 Welding and Heat Treatment

Welding

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.

Butt welds can be welded from one side only, shall be provided with back strips on the whole length of the seam to be welded.

After being deposited, welds shall be cleaned of slag and shall show uniform sections, smoothness of weld metal, feathered 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.

All welds transverse to the direction of flow shall be ground flush with the plates on the inside. Welds shall be ground flush on both the inside and the outside wherever dynamic stress occurs.

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. Where fillet welds are used, the members shall fit closely and shall be held together during welding.

The cut surfaces of plates requiring weld joints 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 painted surface shall be prohibited - all painting materials next to the joint to be welded shall be removed well beyond the heat-affected zone.

Where possible, welding shall be carried out in the workshop. Welding which has to be performed in the field shall be clearly indicated on drawings.

The Contractor shall maintain Weld Procedure Specifications (WPS) for the type of welds to be performed in shop. These WPS shall conform to the recommendations of material Contractors, electrode Contractors and approved standards. The WPS shall be got approved from Engineer. However, approval of the welding process shall not relieve the Contractor of his responsibility for correct welding, the use of correct electrodes and for minimising distortion in the finished structure.

Additional copies of all records of all welding procedures, including preheating and stress relieving, chemical analysis and physical properties, shall be made available to the Engineer upon request.

Welding Qualifications

For welding of principal stress carrying parts, the standard of welding procedures, welders and welding operators shall conform to standards equivalent to the requirements of the ASME Boiler and Pressure Vessel Code, Sections VIII and IX, or DIN 8560, DIN 8563, EN 287

For welding of less important parts, the standards and qualifications shall conform either to the 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.

Quality and Procedure Control

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

All welded joints, which have to be tight, shall be inspected or tested by dye penetration tests.

All major welds carried out on parts under hydraulic pressure shall be at least 10 % radiographically and 100% ultrasonic examined. All welds on the skin-plates shall be additional dye penetration tested as directed by the Engineer.

The Contractor shall indicate in the corresponding drawings the type of non-destructive testing to be carried out during manufacture and at Site.

Defects and Repairs

Plates with laminations discovered after cutting shall be rejected unless the laminated portion is only local and can easily be repaired; such repairs shall require the consent of the Engineer.

Defects in welds, which are to be repaired, shall be chipped out to sound metal and the areas to be DP (Dye penetration) or ultrasonically tested to ensure that the defective material has been completely removed before repair of welding is carried out. Repairs shall be carried out in accordance with the relevant Standards and to the approval of the Engineer. The Contractor shall be fully responsible for the in-service performance of all welding work.

The Work shall be 100% inspected again by the method used first to determine such faulty work.

Heat Treatment

Heat treatment shall be performed on all fabricated parts which are stressed during fabrication as per the approved heat treatment / weld procedure and are to be finish machined.

Heat treatment of field erection welding seams shall be performed according to the specifications for the welding procedure for the corresponding parts, which shall be submitted to the Engineer for approval.

3.10 PROTECTION OF MACHINED SURFACES

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3.10.1 General

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.

3.10.2 Corrosion Protection

All ferrous metal work shall be provided with an effective painted or galvanised finish, applied in accordance with the best trade practice to protect from corrosion.

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 of painting or galvanising shall be included in the Tender Price.

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

i) Painting

Surface Preparation

All surfaces to be painted shall be thoroughly cleaned by suitable means before application of paint. After cleaning the surfaces shall be rinsed in a manner that no residues will remain.

For removing rust and mill scale on structural steel, piping and other steel surfaces, particularly parts which will be in contact with water, exposed to heavy condensation and humidity or subjected to high temperature shall be sandblasted. Parts, which cannot be sandblasted, shall be cleaned of rust by power tool cleaning to the highest degree possible.

The sandblasted clean surfaces shall receive a shop coat with a quick-drying highly pigmented 2-pack zinc-rich primer, unless otherwise specified.

Primed surfaces contaminated with oil or grease shall be de-greased in a manner not affecting the quality of the primer. 2-component coatings older than six (6) months shall be roughened prior to the application of the next coat.

Application Procedure

The most commonly used methods of application are painting by brush, roller, pressure and airless spraying equipment. Selection of the application method depends on the surface to be painted. The quality of the paint shall in no way be negatively influenced.

For all paints the surface temperature of the metal shall not be higher than +50°C during the painting. Concerning special paints, the requirements set by the paint manufacturer shall be followed. All painting shall be free of cracks and blisters and all runs shall be brushed out immediately. After application of the last coat the paint system shall be free of pores.

Parts, which are embedded in concrete, shall be painted with cement base paints.

ii) Galvanising

Unless otherwise specified, all fasteners and steel structures including ladders, platforms, hand rails and the like and all exterior and interior steel surfaces of outdoor Works shall be hot-dip galvanised or electrolytically galvanised.

For galvanising, 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 of sizes above M36 approx. 60 micrometer and for sizes below M36, 25 micrometer.

For all other parts, except for hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 50 micrometer

For hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 100 micrometer.

Cleaning: All material to be galvanised 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 hardware: Bolts, nuts, washers, locknuts and similar hardware shall be galvanised in accordance with the relevant standards.

Straightening after galvanising: All plates and shapes, which have been warped by the galvanising process, shall be straightened by being re-rolled or pressed without injury to the protective coating. Materials that have been harmfully bent or warped in the process of fabrication or galvanising shall be rejected.

3.11 MANUFACTURER'S NAME PLATES

Each important part to be delivered under this Contract shall be equipped with permanent nameplate in readily visible locations. The nameplates shall be protected during erection and especially during painting.

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

- Manufacturer's name
- Work's serial number and year 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 original manufacturer's standard nameplate.

Items such as valves, which are subject to handling, shall be provided with an engraved chromium plated brass name plate or label with engraving filled with enamel.

Nameplates or labels for outdoor equipment are to be of non-corrodible non-hygroscopic material with lettering of a contrasting colour. Labels for indoor equipments shall be engraved with black letters on white trifoliate.

The wording of all labels shall be to the approval of the Engineer prior to the shipment of the plant or equipment.

Miscellaneous Metalwork

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

- All platforms, ladders, guards, handrails of tubular construction and hatch covers necessary for easy and safe access to Works
- 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, cable trenches and access hatches, required for completing the floors around and over the equipment supplied under the Contract will be supplied and installed. Unless otherwise approved, floor plates shall be of an angular pattern.

3.12 TECHNICAL WORKS AND STEEL STRUCTURES

3.12.1 General:

All mechanical Works and steel structures of any mechanical or electrical installation shall comply with these General Technical Specifications, technical specifications for E&M works and relevant standards.

3.12.2 Bolts, Screws, Nuts, etc.

All bolts, studs, screws, nuts, and washers shall be to the ISO metric system. Mild steel bolts and nuts shall be of the precision cold forged or hot forged type with machined faces parallel to one another.

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. Mild steel nuts and bolts shall be zinc or cadmium plated. Stainless steel bolts, nuts, washers and screws shall be used for holding renewable parts in water or when exposed to high humidity

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 M60 shall be drilled for heaters or shall have an extension for pre-tensioning by hydraulic tools.

Fitted bolts shall be a driving fit in the reamed holes they occupy, shall have the screwed portion of a diameter such that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.

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 Works has been completed shall become spare parts and shall be wrapped, marked and handed over to the Purchaser.

3.12.3 Seals

Rubber Seals: Seals shall be designed and mounted in such a manner that they are adjustable, water tight and shall be readily removed and replaced. Seals shall be moulded type and not extruded.

All adjusting screws and bolts for securing the seals and seal assembly in place shall be of stainless steel.

Seals shall be made of synthetic rubber suitable for conditions at the Site and shall be of a material that has proven successful in similar applications. Joints shall be water/oil tight.

3.12.4 Drives

All moving parts of machinery including shafts, couplings, collars, projecting key heads, rope/belt-drives shall be completely guarded to provide full protection. All setscrews on revolving shafts shall be countersunk or suitably protected. All guards shall be arranged so that they can be removed without disturbing the main parts, which they protect.

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

3.12.5 Oils and Lubricants

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

All different types of oils, lubricants, etc., shall be subject to the written approval of the Engineer.

Unless otherwise stated in the Particular Technical Specifications, the first oil or grease filling for bearings, pressure oil systems, transformers, etc., including the necessary quantity for flushing and for the first oil change shall be included in the Tender Price.

3.12.6 Piping, Fittings, Valves and Gates

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.

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.

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 2.00 m from operating floors and platforms.

Where required water piping shall be provided with anti-condensation insulation.

Pipes & Fittings Materials :

Water, air admission and drain piping less than 25mm nominal bore shall be of galvanised heavy grade to IS-1239, Part-I or to schedule `STD' conforming to ANSI B36.10 or equivalent for steel pipe or copper as per relevant standards.

Water, air admission and drain piping equal to or greater than 25 mm nominal bore shall be galvanized heavy grade to IS-1239, Part I/IS-3589 or to schedule `STD' conforming to ANSI

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B36.10 or equivalent.

Oil piping greater than 25 mm nominal bore shall be of seamless high quality steel pipe conforming to minimum API-5L GR.B or equivalent grade as per process requirement, whereas pipes less than 25mm bore shall be of stainless steel.

Steel pipes of diameter 100 mm and above for a pressure of not more than PN 10 may be used in Welded type.

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

Pipe Work Fabrication

Steel pipe work for water, air admission and drains smaller than 65 NB shall be galvanized and joined by screwed fittings. After fitting, unprotected steel be wire brushed and painted with two coats of zinc-rich paint. However, leak-free joint shall be ensured by the contractor.

Steel pipe work for water, air admission and drains 65 NB and over shall be welded ends black pipe hot-dip galvanized after fabrication.

Branches shall be made by welding or brazing. Flanged connections shall be made with approved jointing material, suitable for the duty.

All valves, pumps, etc. shall be connected to the pipe work by sufficient flanges or spherically seated unions to allow their easy removal for servicing or replacement. No screwed or compression fittings shall be used within partitions, walls, or in inaccessible positions.

Pipes shall be cut by saw or pipe cutters and all burrs removed by reaming, Gas cutting will be permitted only if the pipe ends are ground clean and to shape for welding.

Pipes which pass through openings in walls, floors, etc. shall be clear of such openings. Any such holes or openings shall be cleanly and neatly cut or sleeved to a size sufficient to accommodate the pipe with reasonable clearance to allow for movement due to expansion.

Sleeves, in concrete shall be either non-metallic, i.e. PVC or polyethylene, or of the same material as the pipe to pass through the sleeve.

All pipes shall be supported/restrained/anchored in order to contain the forces/moments at the terminal point nozzles within permissible limits as well as not to cause any undue localised stress and deflection/sagging anywhere along the piping length. For the above purpose standard support attachments such as clamps, saddle plates, braces, angles/cleats, guides etc. and support components such as hangers, rods, turn buckles, spring boxes etc. shall be used by the contractor.

Painting

Un-galvanized steel piping shall be painted on the exterior to prevent rusting. The paint treatment shall be of the same system as used for the turbine exterior. Paint damaged during erection and commissioning shall be repaired prior to Handing-Over.

Pressure Testing

Hydraulic piping shall be pressure tested after erection as site. The pressure shall be maintained without loss for one hour.

The lubricating oil piping shall be pressure tested after erection at a pressure 50% greater than maximum pump pressure. The pressure shall be maintained without loss for one hour.

Protection for Transport and Storage

Oil piping shall have a protective coating applied to prevent corrosion occurring during transport and storage. The ends of the pipe lengths shall be plugged to prevent ingress of water.

Pipe work Cleaning

Oil pipe work internal bores shall be chemically cleaned and passivated prior to use. Water, air and drain piping shall be blown through with high pressure air and flushed with water prior to use.

Valves & Gates

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 pressures higher than PN 10 and diameters larger than DN 100 shall be workshop-tested for tightness and soundness of materials.

Valves shall close clockwise and be provided with position indicators/marks on hand wheel. The drive units of motor-driven valves shall also be provided with hand wheels for manual operation.

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 of cast steel. No valve in cast iron body will be accepted.

All pressure reduction valves; safety valves and similar components shall be workshop-tested and provided with a work certificate.

Pipe Supports and Hangers

All pipe work and accessories shall be mounted and supported in a safe and neat manner. All brackets, stays, frames, hangers and supports for carrying and staying the pipes, including their fasteners shall be included in the supply and completed by the Contractor at the Site. Pipes and fittings shall be supported at or near flanges wherever possible.

All heavy valves and other mountings shall be supported independently of the pipes to which they connect, to the satisfaction of the Engineer.

3.12.7 Castings

All castings shall be free from blowholes, flaws, and cracks. All cast-iron shall be of close-grained quality approved by the Engineer.

3.12.8 Mechanical Instruments

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

Pressures 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.

3.12.9 Pumps

Materials of the pumps shall be:

- Casing Cast steel
- Impeller stainless steel
- Shaft stainless steel
- Sleeves stainless steel
- Wear rings bronze
- Keys stainless steel

The impeller diameters shall be neither maximum nor minimum impeller size for the selected pump size.

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.

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

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

3.13 ELECTRICAL WORKS

3.13.1 General

The electrical items of Works 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 highest extent of uniformity and interchange ability shall be reached. The design shall facilitate maintenance and repair of the components.

The Works shall be pre-assembled to the highest possible extent in the Contractor 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 Works (in feeds, 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, de-rating 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 Works shall be suitable for the prevailing climatic conditions.

The Contractor shall ensure that all the supplied Works is insensitive to any signals emitted by wireless communication equipment.

3.13.2 Clearances

The layout of the Equipment on the site shall provide for ready access for operation and maintenance whilst the remaining sections of Equipment are alive. Working clearance provided between isolated Equipment and nearest live metal work shall be as per Indian Electricity rules & Standards.

3.13.3 Electrical Supplies For Auxiliary Equipment

The electricity supplies available for Auxiliary Equipment will be :

- (i) 415 V, 3-phase 50Hz, 4-wire for power
- (ii) 220 V, single phase, 50 Hz for lighting, indication, and anti-condensation heaters.
- (iii) 24 V D.C. for essential indication, controls, protection, alarms and circuit breaker closing and tripping supplies.

3.13.4 Alternating Current Supply Practice

All mains supplies shall be switched and fuse in accordance with the requirements stated in the appropriate Section. Double-pole switches shall be used to break single-phase A.C. mains supplies.

For multi-phase supplies, each phase shall be switched simultaneously and the neutral should preferably not be switched. If it is switched, it shall be opened after and closed before the phase-lines.

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All mains circuits shall be protected only in the phase-lines by fuses of suitable rating or by other suitably protective devices. The neutral shall be connected by a removable link located near the protective devices.

All mains transformers shall have an electrostatic screen which shall be earthed.

Except where the prior approval of the Engineer is obtained, wires external to the equipment shall be coloured in accordance with the current IEC or relevant IS recommendation.

3.13.5 Direct Current Supply Practice

It shall be possible to remove/replace cards from / to electronic equipment without damage and without interfering with the operation of the rest of the equipment or system; if necessary consideration should be given to switching off the supplies locally to a card to prevent inadvertent interference to the equipment or system during removing/replacing a card.

Application of battery or earth via a test lamp to any external interface point or test point shall not lead to any component damage.

Power supply bus bars in cubicles shall be carefully routed and each bus bar shall be shrouded. It shall not be possible to inadvertently short bus bars either between themselves or to earth.

3.13.6 Electric Motors

General

All motors shall be of approved manufacture high starting torque and shall comply - as far as applicable - with ISI 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 eyebolts as suitable.

AC motors shall have squirrel cage type rotors.

Motor Voltages and Power Ratings

The service voltages and corresponding power ratings for electric motors to be used in the Project shall be as follows:

- Motors up to 100 kW

Service voltage	:	3-phase a.c. 415/230 V,50 HZ
Mode of starting	:	direct-on-line up
- Motors up to 0.75 kW

Service voltage	:	single-phase a.c. 230 V,50 HZ
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- Mode of starting : condenser
- Motors intended to work on the d.c. System
- Service voltage : 24 V D.C.
- Mode of starting : resistor

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 5 kW	1.1

A.C. motors shall be capable of operating continuously under rated output conditions at any frequency between 95% and 105% of the rated frequency and/or with any voltage variation between 90% and 110% of the nominal voltage. A transient over voltage of 130% of the nominal voltage shall as well be sustained.

Further, the motors shall be capable of maintaining stable operation when running at 70% nominal voltage for a period of 10 seconds. The pullout torque for continuously loaded motors shall be at least 160% of the rated torque and for intermittently loaded motors 200% of the rated torque.

D.C. motors shall be capable of operating continuously under rated output conditions at any voltage between 90% 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 no-load speed.

Starting

A.C. 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 residual 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.

The maximum starting currents (without any tolerance) shall not exceed the following values:

- 5 times of rated current for L.V. motors rated 100 kW or above
- 2 times of rated current for D.C. motors (by means of starting resistors)

Generally, all motors shall be able to withstand five cold starts per hour, equally spaced. In addition, each M.V. motor shall be capable of enduring two successive starts with the motor initially at operating temperature. Each L.V. motor shall be capable of withstanding three successive starts under the same conditions or once every fifteen minutes without detrimental heating.

Motors for frequent automatic starting shall have an adequate rating. In the motor list the Contractor shall state the frequency of starts permitted in compliance with the motor design.

Insulation Class

The insulation of all motors shall be of class F but maintain in operation the temperature limits of class B materials. It shall be suitable for operation in damp locations, for occasional contact with corrosive gases and vapours and for considerable fluctuations in temperature.

Ventilation and Type of Enclosure

All motors shall be of the totally enclosed fan-cooled type, protection class IP 54 according to IEC Recommendation 144. Cable termination points shall be of class IP55.

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

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

Bearings

As far as possible, the motors shall have sealed ball or roller bearings lubricated for life. All other motors with ratings of about 1 kW 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.

Vertical motors shall have approved thrust bearings.

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.

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.

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. Each equipment/panel shall be earthed by at least two separate earthing strips.

Noise-Level and Vibrations

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

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

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.

Workshop Tests:

- Measurement of winding resistances
- No-load and short-circuit measurements
- Measurement of starting current and torque
- Efficiency measurement (type test)
- Heat test run
- Dielectric test
- Measurement of insulating resistance

3.13.7 Starters And Contactors

Motor starters and contactors shall be equipped with short circuit protection and local disconnecting devices. Preferably, all starters shall be from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V isolating transformer with primary circuit breaker and secondary fuse. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.

Starters and contactors shall comply with IEC 292.1 or NEMA IC 1 and be suitable for direct on-line starting, uninterrupted electrical duty, and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation and weatherproof enclosures for outdoor installation, unless otherwise approved by the Engineer. The enclosures shall be complete with locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards, etc. as required by the duty of the starter or contactor.

Starters and contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal, at nominal frequency.

Thermal type overload and phase failure relays shall be supplied with starters for motors of 7.5 kW or greater. For motors of less than 7.5 kW, suitable rated 3-phase thermal overloads will be acceptable. Ammeters to read current in one phase shall be provided for motors above 7.5 kW.

Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes plus two spare convertible contacts for Owner's use.

3.13.8 Moulded Case Circuit Breakers

All moulded case circuit breakers shall be of 2 or 3-pole type as required, having thermal time delay and instantaneous trips with "On-Trip-Off", indicating/operating mechanism. Circuit breakers used in combination type motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with applicable section of IEC 157/1 or equivalent standards.

3.13.9 Control Relays

Relays used as auxiliary control devices in conjunction with motor starters and magnetic contactors shall be of the type designed for machine tool application featuring contact convertibility. All contacts shall have a minimum thermal current rating of 10A over a range of 6 to 600 V AC.

3.13.10 Terminal Blocks

All terminal blocks shall be mounted in an accessible position with the spacing between adjacent blocks not less than 100 mm and space between the bottom blocks and the cable gland plate being a minimum of 200 mm. Sufficient terminals shall be

provided to allow for the connection of all incoming and outgoing cables, including spare conductors and drain wires. In addition, 20 percent spare terminals shall be provided. In enclosed cubicles, the terminal blocks shall be inclined toward the door for facilitating terminations.

Terminals shall be of the channel mounting type and shall comprise a system of individual terminals so that terminal blocks can be formed for easy and convenient cabling consistent with the high reliability required of the circuits.

Terminal blocks shall be provided with shorting links and paralleling links where applicable and mounting identification numbers and/or letters.

Terminal blocks shall conform to the applicable standards. The smallest size to be used shall be designated for 2.5-sq. mm wire and not more than two conductors shall be connected under one terminal clamp.

Terminal identification shall be provided corresponding to wire number of connected leads.

Circuit terminals for 415 V AC shall be segregated from other terminals and shall be equipped with non inflammable, transparent covers to prevent contact with live parts. Warning labels with red lettering shall be mounted thereon in a conspicuous position.

3.13.11 Equipment Wiring

All wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point.

Multi-conductor cables shall be connected to the terminal blocks in such a manner as to minimise crossovers. Approved claw washers of crimp type connector shall be used to terminate all small wiring. Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilising slip-on ferrules approved by the Engineer.

Markers may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.

Markers must withstand a tropical environment and high humidity and only fungus proof materials will be accepted. Ferrules of adhesive type are not acceptable.

All trip circuits shall employ markers having a red background.

3.13.12 Cubicles And Control Panels

Cubicles and control panel enclosures shall be of sheet steel with minimum thickness of 2.5 mm, of rigid, self-supporting construction and supplied with channel bases.

Cubicles shall be fitted with close fitting, gasketed, hinged, lift-off doors capable of being opened through 180 deg. The doors shall be provided with integral lock and master key.

Cubicles and panels shall be vermin proof. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. The cables and wiring shall enter from bottom or top as approved or directed by the Engineer.

The cubicles and panels shall be adequately ventilated, if required, by vents or louvers. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.

Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.

Unless stated otherwise, all cubicles and panels shall be provided with a ground bus with 40mm copper bar extending through out the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120mm².

All instruments, control knobs and indicating lamps shall be flush mounted on the panels. Relays and other devices sensitive to vibration shall not be installed on doors or hinged panels, and no equipment shall be installed on rear access doors.

The instrument and control wiring, including all electrical interlocks and all interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the manufacturer.

The arrangement of control and protection devices on the panels and the exterior finish of the panels shall be subject to the approval of the Engineer. The interior of all cubicles and panels shall have a mat white finish unless specified otherwise.

Switched interior light and socket outlets shall be provided for all cubicles and control panels.

All cubicles and control panels shall be provided with nameplates, identifying the purpose of the panel and all of its components.

3.13.13 Earthing

Provision shall be made for earthing all equipment intended for connection in an A.C. mains supply. All structural metal work and metal chassis shall be connected to earth. Connection between circuits and metal work shall only be made for reasons of safety and/or reduction of interference. Where such connections are made, they shall not be used as normal current-carrying earth returns.

Earthing conductors shall be at least equal in cross-sectional area to the supply conductors and shall be capable of carrying the fault current.

3.13.14 Labels And Plates

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.

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.

Each separate construction unit (cubicle, panel, desk, box, etc.) shall be identified. 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 anodised aluminium with black engraved inscriptions, arranged at the top section of the units. Manufacturer's trade labels shall - if desired - appear in the bottom section of the units.

All Works inside cubicles, panels, boxes, etc., shall be properly labelled with their item number. This number shall be the same as indicated in the pertaining documents (wiring diagrams, Works 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 switchboards.

3.13.15 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.

2.13.16 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 utilising the aforementioned type of label.

3.13.17 Single-Line Diagrams

Each switchgear room shall be furnished with a copy of the final as-built single-line diagram detailing all electrical data and denominations, separate for each individual switchgear / distribution board / MCCB, 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).

3.13.18 Key System For Electric Boards

Key interlocked switches shall be provided with 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.

The locks or padlocks shall be co-ordinated for the different applications and shall be supplied with three keys. The cabinet door keys shall be similar and shall be six (6) in number.

3.14 INSTRUMENTATION AND CONTROL EQUIPMENT**DESIGN CRITERIA**

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 Works 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 for transportation to site.

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

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

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

All instrumentation and control functions shall be shown on the piping and instrumentation diagrams. The symbols to be used shall be in accordance with ISO standard. The identification system (tag numbers) shall be in accordance with the Works identification system and is subject to approval by the Engineer. All measurements and alarms shall be listed in a measuring list of a standard form 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.

Sizes of Indicators, Recorders, Etc.

The meters, instruments and recorders shall be of 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 degrees type for local control panels but must be 240 degrees type for control room instrumentation.

Tests

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

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

Measuring Systems

Electric measuring signals of 4-20 mA shall be transmitted to the control room for essential or regulating circuits. In this case the absence of live zero signal shall lead to a warning signal. Measuring signals for indicating purposes will be 4-20 mA.

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.

3.14.1 Temperature Measurement

Resistance thermometers and thermocouples shall be equipped with waterproof connection heads. The temperature sensors shall be selected in such a way to minimise the number of different spare inserts.

Resistance thermometers shall be used as far as possible and shall generally be of type Pt 100.

The use of dial-type contact thermometers shall be restricted to bearing metal and oil temperature measuring.

3.14.2 Pressure Measurements

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.

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

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 1.5 mm so that such device can be removed without any disturbance of the plant operation.

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

The adjustment of the pointer shall be possible by means of an adjustment device without removing the pointer from its axle.

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

3.14.3 Level Measurements

The liquid level measurements in reservoirs and tanks with atmospheric pressure shall be made by means of displacement-type transmitters, float-disc-transmitters or capacitance measurement type. The errors shall not exceed $\pm 1.0\%$ of the total measuring range. Level switches shall be of the externally mounted float or displacement operated type.

3.14.4 Electrical Measurements

All Electrical instruments shall be of flush mounted design, dust and moisture-proof. A.C. ammeters and voltmeters shall have digital type system of not less than 1.5 accuracy class for connection to the secondary side of instrument transformers. D.C. measuring instruments shall have digital type systems of the same accuracy. Wattmeters/energy meters shall have electro-dynamic measuring mechanisms if fed by transmitters. Wattmeters shall be suitable for unbalanced systems and accuracy of energy meters should be of 0.2 % accuracy class.

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 instruments and apparatus shall be rear connected, and the enclosures shall be earthed. Means shall be provided for zero adjustment of instruments without dismantling.

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.

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.

All instruments mounted on the same panel shall be of same style and appearance.

All metering circuits shall be terminated in marked terminal blocks for remote metering purposes.

3.14.5 Position Measurements

Position transmitters for continuous position indication and measuring transducers shall have an output current of 4-20 mA and aux. supply voltage (if required) 48 V D.C.

3.14.6 Limit Switches

Limit switches shall be mounted suitable for easy adjustment and for rigidly locking in position after being adjusted. They shall be of heavy-duty rating and have two changeover contacts suitable for 48V D.C. operation.

Switch fixings shall be positive and shall be unaffected by vibration. At the same time they should be capable of easy adjustment to suit changing parameters of the associated plant.

Particular attention shall be paid to potentially harmful environmental conditions, including water, oil, dust, dirt, temperature variations and differential expansions..

3.14.7 Contact Devices

Contacts of level switches, pressure switches, temperature 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.

3.14.8 Protection Systems

Electrical/Mechanical Protection and Interlocking Systems shall be provided for all works components and individual systems to ensure a safe and reliable operation and to limit harm and damage to personnel and works to an utmost extent.

The primary functions of these facilities shall be to disconnect selectively faulty sections of the systems prior to influence or damage to other works and to maintain operative systems as far as possible.

Moreover these devices shall facilitate the duty of the operation staff and prevent mal-operation.

3.15 INSPECTIONS AND TESTS

3.15.1 General

Approval of assemblies, tests, inspections, related procedures etc. and acceptance of pertinent test and inspection certificates, or waiving of inspections or tests, shall in no way relieve the Contractor of his contractual obligations for finishing the Works in accordance with the provisions of the Specifications.

Three (3) sets of all test records, test certificates, performance curves, tables etc. of all inspections and tests, whether or not attended by the Engineer shall be supplied after each inspection or test. After completion of all testing two (2) sets of the above mentioned documents shall be supplied properly bound in books.

All test certificates shall be endorsed with sufficient information for identification of the equipment and material to which the certificates refer.

In addition, the following references shall be entered in the top right-hand corner:

Purchaser's name
 Project title
 Plant's (stage's) name
 Number of Contractor's drawing
 Date

3.15.2 Workshop Inspections And Tests

As far as practicable, quality of materials, workmanship and performance of all items of the Works to be furnished under this Contract shall be inspected at the places of manufacture.

Where the Contractor desires to use stock material, not manufactured specifically for the Works, satisfactory evidence that such material conforms to the requirements of the Contract shall be submitted.

Free and unrestricted access to the Contractor's factory and shops (including those of his Subcontractors) shall be granted to the Engineer also and upon reasonable notice by the Engineer if deemed necessary by the same for additional witnessing of assembly work or inspections and tests.

3.15.3 Material Tests

Unless otherwise specified, the quality of materials shall be verified generally by:

- Chemical analysis
- Mechanical tests (yield point, tensile strength, elongation, and notch impact.)
- Welding tests (welding procedure, welding material, welding tensile strength, welding bend test, welding reversed bend test, etc.)
- Non-destructive x-rays, ultrasonic, magnetic particle, liquid tests, 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 of specifications. Test specimen and samples for analysis shall be plainly marked to indicate 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 cover the whole surface of the casting. After partial machining further tests can be conducted.

Load tests on crane hooks, steel wire ropes, chains and other lifting devices, etc. shall be considered as material tests.

3.15.4 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:

- run out and roundness tolerances of shafts, pistons, etc., to be measured on single parts,
- fits and clearances of bearings, 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.,
- Dimensions of couplings or connections for assembly with other deliveries from the Contractor, Sub-contractors or other contractors.

3.15.5 Workshop 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.

Works 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 Works shall be assembled completely prior to painting.

Field joints shall be temporarily connected. All parts shall be properly matched marked, identified and doweled where practicable, to facilitate correct and quick field assembly and alignment. Where necessary, suitable dowels shall be provided for insertion after field assembly and drilling. The holes for any fitted bolt shall be accurately reamed.

During workshop assembly all instruments, control devices and piping shall be fitted. If the assembly shows defects in the design or manufacture or unforeseen difficulties in assembling and dismantling, these shall be eliminated. If required, design alterations or corrective measures can be executed provided that reliability of operation or inter changeability are not reduced and provided that the agreement of the Engineer has been obtained.

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 Works shall by no means be delivered. The assembled parts shall subsequently be subject to tests as per applicable standards or required by the Engineer.

3.15.6 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.

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 Works and piping shall be thoroughly cleaned immediately after the test.

Leaks and defects can be repaired if permitted by the applicable standards 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.

3.15.7 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 30 minutes. Afterwards the test pressure shall be reduced to the operating pressure.

3.15.8 Functional Tests

Functional tests shall be defined as tests of the function of assemblies, sub-assemblies or parts of the Works under no load conditions. Functional tests shall be performed on all Works prior to the execution of operational tests.

3.15.9 Operational Tests

As far as practicable operational test shall be carried out on all Works, simulating operating conditions.

Parts to be delivered by sub-Contractors shall be tested either at the premises of the sub-Contractor or of the Contractor, as agreed by the Engineer.

Testing of the electrical Works shall be performed in accordance with applicable Standards; they shall include but not be limited to tests of heating, loading, overloading, and losses.

Operational tests of lifting equipment and other machinery shall include tests under nominal load and 125 % of nominal load unless otherwise specified.

3.15.10 Electric Tests

Electrical Works shall be tested in accordance with applicable Standards and agreed test programs and procedures.

3.15.11 Type Tests

Type tests for certain parts of the work or Works shall be carried out as specified or agreed between Contractor and Engineer.

3.16 ERECTION AND COMMISSIONING**3.16.1 Preparation And Installation**

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.

3.16.2 Reference Points

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 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.

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.

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.

3.16.3 General Notes On Installation Work

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 provide all hoisting equipment, staging and scaffolding, winches and wire ropes, slings, tackles and all other appliances and temporary materials.

The Contractor shall comply with all applicable and approved safety regulations while carrying out the works on 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 damages. He shall be responsible for adequate protection of persons, plant and materials against injuries and damages resulting from his operations.

The Contractor shall be responsible that the installation of all plant 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 in specifications and 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 recorded. Copies of these records shall be given to the Engineer. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc. embedments.

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 secured adequately. Steel wedges shall be secured by welding. Wooden wedges shall not be used. Fixing of 1st, 2nd and 3rd stage embedments (as the case may be) should be done so as to match the concreting schedule of civil contractor.

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.

After concreting, the control measurements shall be verified again, indicated in the above-mentioned records and submitted to the Engineer.

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.

If for installation purposes auxiliary structures have been attached to the plant, they shall be removed after completion of work and the surface restored to proper condition by grinding and repainting.

Special care shall be taken not to damage surfaces of galvanised or specially treated plant during erection. Care shall be taken to prevent or remove any rust streaks or foreign matters deposited on galvanised or otherwise finished surfaces during storage or transport or after installation.

Glass parts or other parts, which can easily be damaged, shall be provided with suitable protective sheaths or coverings during installation.

Machined or bare metal surfaces, which are to receive no coat of paint, shall be protected during transportation, storage and erection by a suitable anti-corrosion film.

All power tools preferably are operated pneumatically. They are to be handed over at the end of the installation work in good condition in accordance with the Engineer's instructions.

After erection, the works shall be finally painted, in accordance with the painting specification, and any damaged paintwork shall be restored.

The Contractor shall keep the site in clean condition during erection and commissioning time. On instruction of the Engineer he shall remove waste from the place of installation to the defined deposit site at his own cost.

3.17 PAINTING OF WORKS AT SITE

Painting Materials

Coating materials shall be standard products of a paint manufacturer with proven experience in the field of corrosion protection of the type of Works to be supplied.

Paint material shall be delivered in unopened original containers bearing the manufacturer's brand name and colour designation, storage directions and handling instructions. The entire paint material for a particular specified paint system shall be supplied by one manufacturer only; who shall guarantee the compatibility and quality of the paint material. A complete list of the proposed paint material shall be submitted to the Engineer. For multicoated painting systems each coat shall have a different colour.

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-radiation, 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 Contractor shall submit to the Engineer for approval an overall colour scheme in accordance with the Particular 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. .

Preparation of Paint Material

Paint shall be delivered ready mixed wherever possible. Adding of diluting agents and mixing of two or multi-component systems shall be done in the field in accordance with the directions of the manufacturer. After mixing, the paint shall be poured into a clean container to ensure that no settled pigments are at the bottom.

Application: The most commonly used methods of application are painting by brush, roller, pressure and airless spraying equipment. Selection of the application method depends on the surface to be painted. The quality of the paint shall in no way be negatively influenced. The manufacturer's directions shall govern the choice of application method. Inaccessible surfaces shall be painted prior to erection with prime and finish coats according the specification. Areas inaccessible to spraying equipment shall be painted by brush. Corners and edges shall be pre-coated. Bolts, screws, studs, rivets etc. shall be painted as a whole with the complete paint system after erection.

The primer shall be applied to an absolutely clean and dry surface only. Temperature and dry-out time shall be in accordance with the manufacturer's directions. Whenever possible the prime coat as well as one intermediate coat shall be applied in-doors at the Contractor's shop.

During painting the air temperature shall be at least +5°C and the temperature of the items being painted must be at least 3°C above the dew point. During drying of the paint, the temperature shall not be below 0°C. For all paints the surface temperature of the metal shall not be higher than +50°C during the painting. Concerning special paints, the requirements set by the paint manufacturer shall be followed.

Cleaning and painting work shall be interrupted outdoors and in non-conditioned rooms under the following conditions: rain, fog, dew, and polluting winds, sand and other dusts. Surface preparation and application of the first paint layer are parallel operations to be carried out within a maximum delay of 4 hours.

All painting shall be free of cracks and blisters and all runs shall be brushed out immediately. After application of the last coat the paint system shall be free of pores. After erection of the equipment all damages to painted surfaces shall be repaired. Welds, rusty spots, slags, beads, flux deposits etc. shall be repaired and repainted. For touching up, the same materials shall be used as for the main painting work. Repaired finish coats shall be of the same appearance as the original coating.

Remove electrical plates, surface hardware, fittings and fastenings before starting painting operations. Carefully store, clean, and reinstall after completion of work.

Repair of Primer and Finish Coats

For touching up, the same paint shall be used as for the original painting work. Repaired finish coats shall be of identical appearance with the original and no difference in the colour shall occur.

Galvanised and Painted Structures

Surface Preparation: Thorough cleaning of the damaged surface i.e. removal of oil, grease, dust, etc.

Repair of Coatings: Two coats of 2-component epoxy-resin micaceous iron oxide (mio) paint. Total film thickness min. 0.160 mm. The colour of the paint shall be the same as originally applied.

Painted Structures

Repairs on painted structures shall be carried out as follows:

Surface Preparation: Scraping, wire brushing or grinding to Grade ST 3 according to SIS 055 900-1967.

Prime Coat: One coat of 2-component epoxy resin zinc-chromate primer. Dry film thickness minimum 0.050 mm.

Parts, which are embedded in concrete, must not be protected against corrosion. However, transition zones of large steel pipes and of steel linings shall be painted over a length of 1 m within the concrete, all other concreted in steel surfaces over a length of 200 mm within the concrete.

Quality Control of Painting

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 to be arranged by Contractor.

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.

3.18 SITE INSPECTION AND TESTS

During erection, commissioning and trial operation, the Contractor shall perform at suitable intervals 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.

Unless otherwise specified, all costs for testing at site and of the works and charges associated with it shall be borne 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.

The Engineer reserves the right to have checked at his own expenses the Contractor's instruments to be used or having been used for any tests by an independent, officially acknowledged institution.

The Contractor's testing at Site shall be complete in every respect to prove the successful performance and operation of all the works and Works supplied and erected under the Contract.

In case of disagreement between the Engineer and Contractor(s) on the test results, an independent expert shall be appointed by Purchaser to whom both parties shall agree. If no amicable settlement can be reached, the Arbitration Clause shall be applied.

For the procedure of inspections and test at site, notice to the Engineer, reports, commissioning, trial runs and trial operation, and acceptance tests refer to General Conditions of Contract.

3.19 COMMISSIONING TEST

Commissioning acceptance tests shall be carried out, on all generating units to verify the rating characteristics of generating units and other equipment's in accordance to relevant standards. The complete field acceptance test reports shall be prepared by the Contractor and submitted to Purchaser for approval.

The test run on generating units shall be carried out as per relevant provisions of IEC standards.

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.

3.20 TRIAL RUN

Immediately upon completion of commissioning, the plant shall be kept on trial operation during which period all necessary adjustments shall be made while operating over the full load-range enabling the plant to be made ready for performance and guarantee tests. The plant, i.e., complete equipment, shall be on Trial operation for a period of one month.

The trial operation shall be considered successful, provided that each item of the equipment can operate continuously at the specified operating characteristics, for the period of trial operation.

For the period of trial operation, the time of operation with any load shall be counted. Minor interruptions not exceeding 3 (three) hours, at a time, caused during the continuous operation shall not affect the total duration of trial operation. However, if in the opinion of the purchaser, the interruption is long, the trial operation shall be prolonged for the period of interruption.

The trial operation report comprising of observations and recordings of various parameters to be measured in respect of the above trial operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during trial run, shall also

include the dates of start and finish of the trial operations and shall be signed by the representatives of both the parties. The report shall have sheet, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the trial operation. Based on the observations, necessary modifications, repairs to the plant shall be carried out by the Contractor to the full satisfaction of the purchaser to enable the latter to accord permission to carry out the performance and guarantee tests on the plant. However, minor defects, which do not endanger the safe operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

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During the trial run the Contractor shall make familiar the Purchaser's personnel with the equipment, the operation and maintenance of the Works and its auxiliaries to such extent that thereafter the duties can be assigned to the Purchaser's trained personnel.

If any defects or irregularities affecting the safety or reliability of the Works should arise during the trial run, the trial run shall be interrupted and started again after such defects or irregularities have been corrected by the Contractor at his own cost.

3.21 PERFORMANCE AND GUARANTEE TESTS

- (i) The final test as to the performance and guarantees shall be conducted at site, by the contractor in presence of the Department representative. Such tests will be commenced, within a period of 15 (fifteen) days after successful completion of Trial Operations. Any extension of time beyond the above 15 (fifteen) days shall be mutually agreed upon.
- (ii) These tests shall be binding on the Contract to determine compliance of the equipment with the performance guarantees.
- (iii) The available instrumentation and control equipment will be used during such tests and the contractor will calibrate, all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken in to account in a reasonable manner, for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable.
- (iv) Any special equipment, tools and tackles required for the successful completion of the performance and guarantee tests shall be provided by the contractor.
- (v) The guaranteed performance figures of the equipment, shall be proved by the contractor during these performance and guarantee tests. Should the results of these tests show any decrease from the guaranteed values, the contractor shall modify the equipment as required to enable it to meet the guarantees. In such case, performance and guarantee tests shall be repeated within one month, from the date the equipment is ready for retest and all cost for modifications including labour, materials and the cost of additional testing to prove that the equipment meet the guarantees, shall be borne by the contractor.
- (vi) The contractor is to keep the project in operation successfully for a period of 3 (three) months after commissioning at the cost of the contractor.

All the costs for the pre-commissioning test, trial operation, performance and guarantee test including the consumables shall be borne by the contractor.

3.22 TRAINING OF GOVERNMENT PERSONNEL

The contractor shall impart training at least for a period of two months from the date of successful commissioning of the project on operation and maintenance of the plant. However, the engineer personnel/officers/staffs shall be associated for the purpose of training right from the stage of installation of the equipments. Such training shall be imparted at free of cost to the engineer personnel / officers to enable them to make themselves conversant in the operation and maintenance of plants and equipments.

3.23 TAKING OVER OF THE PROJECT

After conclusion of the training period of Govt. Personal as specified in Clause 28 above, the contractor shall give due notice to the Department about successful operation of the plant and conclusion of the training period. Thereafter the Department shall take over the project formally subject to fulfillment of all relevant requirements in terms of this agreement.

3.24 ACCEPTANCE

The taking-over testing of any part or section of the Permanent Works, which can operate as an independent unit, shall be performed as per the test procedure agreed upon between Engineer and Contractor.

Immediately upon termination of any such testing of a part or section of the permanent Works a "Protocol of Acceptance" which shall be deemed to be the Test Certificate required by General Conditions of Contract shall be issued by the Engineer.

This document shall be signed by an authorised representative of the Purchaser, the Engineer and the Contractor and shall form an integral part of the later "Taking-Over Certificate".

This "Protocol of Acceptance" shall state:

- The date of testing
- The quantity and type of Works concerned
- Statement of all minor defects which have to be corrected by the Contractor
- Confirmation that the guaranteed data have been proven

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 "Protocol of Acceptance" and be postponed for a mutually agreed period.

However, the tested part or section of permanent work shall continue to be operated by the Purchaser with the help of Contractor's personnel, till both Generating units have been tested and commissioned and trial run period of 10 days or that to be agreed with the Owner and the Contractor, has been completed in respect of last unit to be commissioned.

LIST OF APPLICABLE STANDARDS

A. STANDARDS FOR GENERAL APPLICATIONS

- AISI American Iron and Steel Institute
- ANSI American National Standards Institute
- ASME American Society of Mechanical Engineers
- ASTM American Society for Testing and Materials
- AWS American Welding Society
- BS British Standards
- CMAA Crane Manufacturers Association of America
- DIN Deutsche Institute für Normung
- IEC International Electro-technical Commission
- IEEE Institute of Electrical and Electronic Engineers

- IPCEA Insulated Power Cable Engineer's Association
- IS Indian Standards
- ISO International Standards Organisation
- JEC Standards of the Japanese Electrotechnical Committee
- JIS Japan Industrial Standards
- NEMA National Electrical Manufacturers Association
- VDE Verein Deutscher Elektroingenieure
- VDI Verein Deutscher Ingenieure

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

B. ELECTRICAL AND INSTRUMENTATION

S.No.	DESCRIPTION		INDIAN
1.	Rotating electrical machines	IEC 34	IS:4722-1968
2.	Direct action indicating electrical measuring instruments	IEC 51	
3.	Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV	IEC 55	
4.	High voltage alternating current circuit breakers IEC 56	IS:2516-1980	
5.	Basic environmental testing procedures	IEC 68	
6.	Insulation co-ordination	IEC 71	
7.	Dimensions and output ratings for rotating electrical machines	IEC 72	
8.	Colours for indicator lights and push buttons	IEC 73	
9.	Power Transformers	IEC 76	IS:2026
10.	Classification of materials for the insulation of electrical machinery	IEC 85	
11.	Primary Batteries	IEC 86	
12.	Lead Acid Starter Batteries	IEC 95	
13.	Lightning Arrestors recommended graphic symbols	IEC 99	
14.	Alternating current disconnectors (isolator) and earthing switches	IEC 129	

15.	Bushings for alternating voltages above 1000 V.	IEC 137	
16.	Degrees of protection for low voltage switch gear and control gear	IEC 144	
17.	Low voltage switchgear and control gear	IEC 157	
18.	Low voltage control gear tests on indoor and outdoor post insulators for voltages greater than 1000 V.	IEC 168	
19.	Current transformers	IEC 185	IS:2705
20.	Voltage transformers	IEC 186	IS:3156
21.	Low frequency cables and wires with P.V.C. insulation and PVC sheath	IEC 189	
22.	On-load tap changers	IEC 214	
23.	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V.	IEC 227	
24.	Conductors for insulated cables	IEC 228	
25.	Impulse tests on cables and their accessories	IEC 230	
26.	Electrical relays	IEC 255	IS:3231-1965
27.	Low voltage fuses calculation of the continuous current rating of cables (100% load factor)	IEC 287	
28.	Low voltage motor starter	IEC 292	
29.	Specification for new insulating oil for transformers and switchgear	IEC 296	
30.	AC metal-enclosed switchgear and control gear for rated voltages above 1 kV up to and including 72.5 kV	IEC 298	
31.	Standard colours for insulation for low frequency cables and wires	IEC 304	
32.	Guide to the calculation of resistance of plain and coated copper conductors of low-frequency cables and wires.	IEC 344	
33.	Loading Guide for oil immersed transformers	IEC 354	
34.	Marking of insulated conductors	IEC 391	
35.	Report on synthetic testing of high voltage alternating current breakers.	IEC 427	
36.	Factory-build assemblies of low voltage switchgear and control gear	IEC 439	

37.	Identification of insulated and bare conductors by colours	IEC 446	
38.	Standard directions of movement for actuators which control the operation of electrical apparatus	IEC 447	
39.	Methods of measurement of radio equipment used in their mobile services	IEC 489	
40.	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto 30 kV	IEC 502	
41.	Class 0.5, 1 and 2 alternating current Watt-hour meter	IEC 521	
42.	Test methods for insulations and sheaths of electric cables and cords	IEC 540	

C. TURBINES, GENERATORS AND ANCILLARY PLANT

1. International Code for Field Acceptance Test of Hydraulic Turbines Publication 41 (IEC - 41)-1963.
2. The IEC publications 308 'International code for testing of speed governing systems for hydraulic turbines' shall be an integrated document of the governor specification.
3. Test code for Hydraulic Prime Movers, ASME Power Test Codes, ASME-New York 1949.
4. Electromechanical Equipment Guide for Small Hydroelectric Installations (IEC-1116-1992-10)
5. International Code for Model Acceptance Tests of Hydraulic Turbines 193-1965-193A-1972.

D. CODE AND STANDARDS

In complement to the standards specified in generator section, the particular following standards shall be applied ;

1. Bolt calculation : VSM 14 332;
2. Vibrations : VDI 2 056;
3. Shaft coupling : ANSI B 49.1;
4. Shaft alignments : NEMA;
5. Rotating electrical machines; IEEE 30.4 to 34.11;
6. Test Procedure for Synchronous Machine; IEEE 115

E. INDIAN STANDARDS

S.No.	IS:CODE	DESCRIPTION
1.	IS:4722-1968	Rotating electrical machines
2.	IS:325-1978	Three phase induction motors
3.	IS:8789-1978	Values of performance for three-phase induction motors
4.	IS:3156	Voltage transformers
5.	IS:L3156(Pt.I)-1978	General requirements
6.	IS:3156(Pt.II)-1978	Measuring voltage transformers
7.	IS:3156(Pt.III)-1978	Protective voltage transformers
8.	IS:3156(Pt.IV)-1978	Capacitor voltage transformers
9.	IS:2705	Current transformers
10.	IS:2705(Pt.I)-1981	General requirements
11.	IS:2705(Pt.II)-1981	Measuring current transformers
12.	IS:2705(Pt.III)-1981	Protective current transformer
13.	IS:2704(Pt.IV)-1981	Protective current transformers for special purpose applications
14.	IS:2026	Power transformers
15.	IS:2026(Pt.I)-1977	General
16.	IS:2026(Pt.II)-1977	Temperature-rise
17.	IS:2026(Pt.III)-1981	Insulation levels and dielectric tests
18.	IS:2026(Pt.IV)-1977	Terminal markings, tappings and connection
19.	IS:335-1983	New insulating oils
20.	IS:3231-1965	Electrical relays for power system protections
21.	IS:3043-1966	Code of practice for earthing
22.	IS:1651-1979	Stationary cells and batteries lead-acid type (with tubular positive plates)
23.	IS:2516-1980	Circuit-breakers
24.	IS:2147-1980	Degree of protection provided by enclosures for low voltage switchgear and control gear
25.	IS:L1554(Pt.II)-1976	For working voltages upto and including 1100 V
26.	IS:5613(Pt.I/Sec.I) 1978	Lines upto and including 11 kV, section 1 Design.

