

6.5.5 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 be disconnecting link type for CT, PT and incoming supplies AC/DC & for balance fixed link type conforming 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.

6.5.6 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.

Splices or tee connections between terminal points are not acceptable. Wire runs shall be neatly trunked inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipments.

Multiconductor 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 in-Charge.

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.

Sensitive control circuits shall be effectively shielded against extraneous signals and interference. A separate terminal shall be provided for termination of individual cable shields, which will be grounded at source end only.

6.5.7 Alarm contacts

Where applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices.

- i) Local annunciator
- ii) Station annunciator
- iii) Supervisory control and sequence of events / fault recorder system.

All alarm contacts shall be changeover type. Where required, relays shall be provided as contact multiplier.

6.6 Cables

The General Cable Specification shall include the calculation of the derating factors for the individual modes of installation at applicable ambient temperatures and grouping of cables, and furthermore, for each cross section:

- i) The rated current carrying capacity
- ii) The max. Short-circuit capacity
- iii) The voltage drop
- iv) Type, insulation serving, armouring and sheathing of cable
- v) Type, description and catalogue/pamphlet of cable termination.

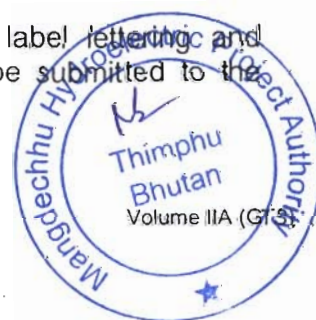
Separate specification(s) shall be prepared for cable trays, conduits, supporting structures and other accessories.

6.7 Labels and Plates

6.7.1 General

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 in-Charge for approval.



Where applicable, designations in the selected local language shall appear above or to the right of the designation in the Contract language. The translations into and writings in the local language shall be submitted for approval.

6.7.2 Equipment Labels and Instruction Plates

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

Each separate construction unit (cubicle, panel, desk, box, etc.) shall be identified by its Works identification number. Cubicles and similar units shall also bear this identification number on the rear side if rear access is possible. The overall designation of each unit shall be given in the Contract language and, if required, also in a selected local language. These labels shall be made of anodised aluminium / stainless steel 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.

6.7.3 Warning Labels

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

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

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

6.7.4 Labels for Conduits, etc.

The material shall be non-corrosive and the description be done with 10 mm high letters/figures.



6.7.5 Labels for Cables

Each cable when completely installed shall have permanently attached to each end and at intermediate positions as may be considered necessary by the Engineer in-Charge, 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.

6.7.6 Rating Plates

Works (hoists, machines, transformers, etc.) rating plates and other technical data/informative plates shall either be of the enamelled type or be of stainless steel suitably protected after engraving with a transparent paint resistant to aggressive atmosphere and solar radiation.

6.7.7 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 / MCC, placed under glass and frame/wall mounted at an approved location.

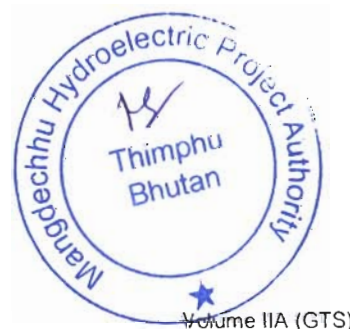
The same applies to the Station Single-Line Diagram one copy of which shall be arranged in the control room(s).

6.8 Key System for Electric Boards

Key interlocked switches shall be provided with 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. A key cabinet at the end of each board (distribution board, MCC, control cubicles, etc.) shall be provided for storing the keys of that board. All keys shall have six master keys to open any lock or padlock supplied. Each key shall have one identification label fixed above the key-hanging hook inside the cabinet.

The cabinet door keys shall be similar and shall be six (6) in number.



7 INSTRUMENTATION AND CONTROL EQUIPMENT

7.1 General

All instrumentation and control equipment shall be of internationally reputed make having proven performance and acceptability in the field.

7.2 Design Criteria

7.2.1 General

Chapter 6, "Electrical Works", shall be considered for I & C equipment as far as applicable. Special reference is made to cabling, wiring and labelling.

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 is 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 in-Charge. All measurements and alarms shall be listed in a measuring list of a standard form subject to Approval by the Engineer in-Charge. 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.

7.3 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.

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

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

7.3.1 Temperature Measurements

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

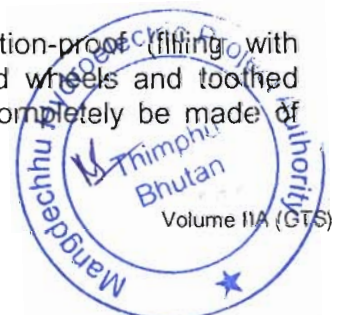
Resistance thermometers and thermocouples shall be equipped with waterproof connection heads. Thermometer arrangements shall be such that the connection heads do not become warmer than 80 °C, and the measuring inserts are easily exchangeable.

The temperature sensors shall be selected in such a way to minimise the number of different spare inserts. Resistance thermometers shall be used as far as possible and shall generally be of type Pt 100. Double resistance thermometers (with two resistors in one insert) should be avoided.

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

7.3.2 Pressure Measurements

- 1) Pressure gauges shall be shock and vibration-proof (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.



- 2) Higher than rated pressure shall not deteriorate the pressure gauge or affect its calibration. The pressure gauges shall be equipped with a radial-connecting stud, to allow the mounting on a gauge holder.
- 3) The accuracy for the pressure gauges and pressure switches shall not be less than $\pm 0.5\%$ FSR. The error for pressure transmitters shall be limited to $\pm 0.5\%$.
- 4) Pressure gauges and transmitters for inflammable liquids shall have filled systems and the filling liquid shall be separated from the inflammable liquid by means of adequate isolating membranes.
- 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.
- 6) Pressure gauges and transmitters for pressures of 10 bar and above shall not be directly mounted on the pressure tapping point. They shall be mounted apart from the tapping point on gauge holders or gauge boards. Whenever possible, pressure gauges and transmitters shall be group wise combined on racks or consoles.
- 7) Pressure gauges for high pressures shall be equipped with a relieve valve for safety reasons in case of leaks (with a rubber reverse flow check).
- 8) In case of flowing substances, the measuring point shall be selected in locations of undisturbed flow.
- 9) If the pressure is pulsating, the devices concerned shall be connected via flexible tubes or other pulse-absorbing means.
- 10) In general, all pressure gauges, transmitters and pressure contacts shall easily be accessible for maintenance and supervision.
- 11) The scales shall have preferably a diameter of 150 mm with black letters and figures on a white ground. The calibration shall be in "bar".
- 12) The adjustment of the pointer shall be possible by means of an adjustment device without removing the pointer from its axle.
- 13) The high and low-pressure connections of differential pressure gauges shall be marked accordingly.
- 14) All casings shall be dust and watertight made of stainless steel having preferably IP 67 protection class and be provided with toughened glass.

7.3.3 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. Watt meters/energy meters shall have electro-dynamic measuring mechanisms if fed by transmitters. Watt meters shall be suitable for unbalanced systems and accuracy of energy meters should be of 0.2 % accuracy class or better.

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.

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

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

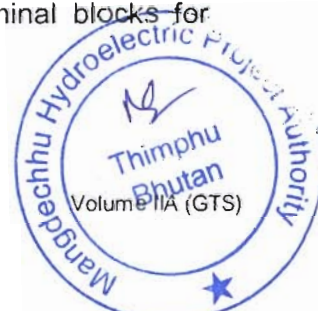
All instruments shall be of the flush mounting type and shall be fitted with non-reflecting glass and shall comply in every respect with the requirements of IEC Publication 51.

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.

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

Transmitter connected ammeters (for example those in mosaic-type control desks) shall have 90 degrees or 240 degrees circular scales calibrated 0-120 %. The rated motor current shall correspond to 100% scale indication.

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



7.3.4 Position Measurements

- 1) Position transmitters of the potentiometer type will not be accepted. Inductive or capacitive type shall be provided.
- 2) Position transmitters for continuous position indication and measuring transducers shall have an output current of 4-20 mA and aux. supply voltage (if required) 220 or 48 V D.C. The "potentiometer-type" position measuring principle is not permitted.

7.3.5 Limit Switches

Limit switches shall be provided for each electrically operated gate, valve or gantry to automatically stop the motor at both ends of travel. Additional switches shall be provided where necessary for control, interlocks and indication.

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 220 V D.C. operations.

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. Where switches operate through linkages, precautions shall be taken to eliminate variations of settings and incorrect operations resulting from wear or tolerances.

7.3.6 Contact Devices

Contacts of level switches, pressure switches, temperature switches, limit switches, and of all other devices shall be of the snapaction 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.

7.4 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.

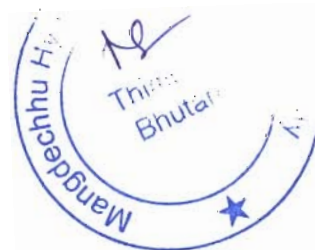


7.5 Transmitter Racks and Piping

Wherever practicable, transmitters for flow, pressure, etc., shall be installed in readily accessible positions in the proximity of the measuring point, free from vibration and protected against damage, moisture, dust, corrosive air, and great temperature changes.

The transmitters shall be grouped and assembled as far as practicable on local transmitter racks or in cubicles with glass or plexi-front.

The connecting lines between the primary elements and the transmitters shall be installed to falls in order to ensure that no air pockets or water locks are created.



8 TRANSPORT AND INSTALLATION

8.1 General

Shipping, loading, transportation, unloading, storage, erection and test running shall be performed by the Contractor.

From the time of manufacturing until commissioning all parts of the plant shall be protected and insured at the Contractor's expense against damage of any kind. Parts, which are damaged during transport, storage, erection or trial operation, shall be replaced at the Contractor's expense.

The Contractor shall provide the Engineer in-Charge with complete packing lists of each performed shipment.

8.2 Packing

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

After the workshop assembly & prior to dismantling for shipment to the site, all items shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so they are clearly visible.

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

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

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

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

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

The material used for shipment of material frame at manufacturer's works withstanding the above shall be preferably environment friendly. Biodegradable packing shall be used to the extent possible.



The Engineer in-Charge reserves the right to inspect & approve the packing before the items are dispatched but the contractor shall be entirely responsible for ensuring that the packing is suitable for transit & such inspection will not exonerate the contractor from any loss or damage due to faulty packing.

8.3 Marking

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

- i) Consignee
- ii) Contract No.
- iii) Country of Origin
- iv) Port of entry
- v) Item number (if applicable)
- vi) Package number, in sequence and quantity per package
- vii) Description of Works
- viii) Net and gross weight, volume

8.4 Transport and Storage

The Contractor shall inform himself fully as to all relevant transport facilities and requirements, loading gauges and other limitations and shall ensure that the equipment as prepared for transport shall conform to such limitations. The Contractor shall also be responsible for obtaining from the Indian railway or highway authorities any permit that may be required for the transport of loads exceeding the normal gauges.

The Contractor shall provide means for all unloading and reloading for all consignments of plant; both during transport to Site and on the Site. Consignments shall be unloaded immediately on arrival at Site. The Contractor is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc.

All parts of the plant shall be brought, as far as possible, to their final place of erection. The Contractor shall construct their own storage facilities at site.

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

Bolts, pins, packing, tools, insulation materials, electrical parts with electrical devices attached, electric motors and excitation equipment, instruments, welding material and equipment, all small parts and all parts of the plant which already have been finally painted.



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

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

All the equipment shall be stored as per standard storage and preservation instructions etc. of the suppliers.

8.5 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.

The result of this check shall be reported to the Engineer in-Charge in due time to allow any errors to be corrected before the commencement of erection. All parts of the plant shall be cleaned carefully of all contamination such as dust, sand, rust, mill scale and other dirt prior to installation.

8.6 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, profiled templates and centre lines and shall establish all such permanent markings and recovery marks as may be required by the Engineer in-Charge for checking the Contractor's setting-out. The Contractor shall be responsible for rectifying, at his own cost, all work rejected by the Engineer in-Charge due to errors in setting-out.

All bench marks, notch marks, pegs and signals on the surface, alignment pins and the like put in by the Engineer in-Charge for the purpose of checking the Contractor's work or as permanent survey marks will be under the care of the Contractor during the period of the Contract. He shall, at his own expense, take all proper and reasonable care and precautions to preserve and maintain them in their true position where such marks are within or adjacent to his work area. In the event of their being disturbed or obliterated by any cause whatsoever, they may, if so determined by the Employer, be replaced by the Engineer in-Charge at the Contractor's expense.

The Contractor shall be responsible for the true and proper staking-out of the works and levels of reference given by the Engineer in-Charge in writing, for the correctness of the positions, levels, dimensions and



TRANSPORT AND INSTALLATION



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 in-Charge or the Engineer in-Charge's Representative shall not in any way relieve the Contractor of his responsibility for its correctness.

8.7 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 erection staging and scaffolding shall be provided with coverings and barriers and shall guarantee safe working conditions.

The Contractor shall comply with all applicable and approved safety regulations while carrying out the works on Site and with all reasonable requirements of the Engineer in-Charge. 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 plant or parts to be installed shall not be overstressed during the process of installation.

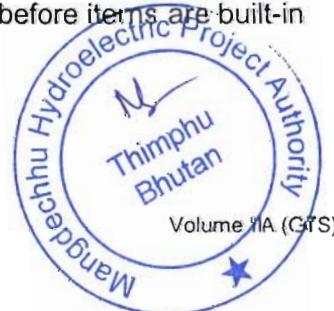
The Contractor shall be responsible that the installation of all plant is properly executed to the correct lines and levels and in accordance with the manufacturer's instructions and the Contract requirements.

The alignment of the plant shall be done exactly; the tolerances 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 in-Charge. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc.

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.

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 in-Charge 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 in-Charge.

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.

Welding, torch-cutting and drilling work on the plant to be erected shall only be carried out with the approval of the Engineer in-Charge only for modification if any.

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

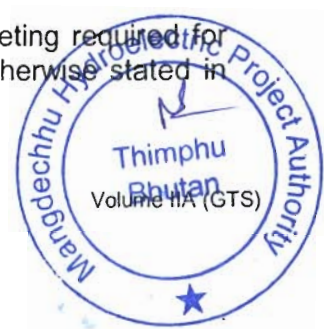
After erection, the works shall be finally painted, in accordance with the painting specification, and any damaged paintwork shall be restored.

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

8.8 Civil Site Work

The following works shall be carried out as part of the civil works contract and is not included within the scope of work covered by the equipment specifications.

- i) All concrete work, including reinforcement and form-work, and all grouting required for filling in, around and under the various parts of the works to be embedded in concrete.
- ii) All necessary excavation and backfilling / concreting required for installing the plant in its final position, unless otherwise stated in the Particular Technical Specifications.



- iii) Building in of all required parts into the first stage concrete. The readiness of such parts shall be communicated to the Engineer in-Charge and they shall be delivered in due time by the Contractor unless otherwise specified or agreed in the Contract.
- iv) Providing and grouting the blackouts for all anchoring and foundation bolts needed to support and fix the plant in its final position.
- v) All protective measures, e.g., pumping, etc., to keep the various parts of the plant and the erection site free from water during the time of erection.
- vi) Provision of cable and pipe ducts, trenches, block-outs, drilling for grounding system etc., in accordance with the drawings supplied by the Contractor and supervised by the Contractor.
- vii) Adequate safety covers and protective measures against injury or damage to the Contractor's employees and equipment and to the works due to any operations of the civil contractor.
- viii) Anchors may be provided with concrete pads & with embedded plates, of appropriate size at mutually agreed height(s) and spacing on upstream and downstream walls.
- ix) Embedded plates and hooks in different floors, ceiling, walls etc. may be kept in the scope of civil.

The Contractor shall level and adjust all parts of the equipment on the foundations and after each item is set up and the Engineer in-Charge's approval obtained, grouting or concreting will be carried out by other contractors and verified by the Contractor. The Contractor shall be responsible for ensuring that such work is carried out to his satisfaction and that level and adjustments made by him are not disturbed by the grouting operation. The Contractor shall be responsible for ensuring that the positions, levels and dimensions of the Works are correct according to the drawings notwithstanding that he may have been assisted by the Engineer in-Charge in setting out the said position, levels and dimensions



Volume IIA

ANNEX-1

PAINTING SYSTEM



PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
A	Unmachined internal surfaces of indoor ferrous parts in water contact such as draft tube cone, bottom ring, discharge ring, spiral case, head cover, main inlet valves including other wetted internal ferrous surfaces of turbine.	Sa 2 1/2 - 3	Prime Coat: 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	
			Intermediate Coat: 1 x coal tar epoxy, 2-components	1 x 125	The colours of intermediate and finish coats shall be black - brown - black
			Finish Coat : 1 x coal tar epoxy, 2-components	1 x 125	
			Total	300	

PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
B	External surfaces of Cranes, Lifting Beams, Fixed Hoist, and other similar Drive Supports	Sa 2 1/2 - 3	Prime Coat: 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	The pure metallic zinc shall be at least 92% of the polymerized film
			Intermediate Coat: 2 x micaceous iron oxide paint, 2-component Base : epoxy resin	2 x 80	This paint system is for temperatures up to 60°C
			Finish Coat : 1 x micaceous iron oxide paint, coloured, 2-component Base : epoxy resin	1 x 80	
			Total	290	



PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
C	Unmachined external surfaces of indoor ferrous parts which are directly exposed to air such as draft tube cone, bottom ring, discharge ring, head cover, bearing supports & housing, pit liner, regulating ring, servomotors, accumulator, main inlet valves, connection pipes, oil/ air tanks, lower & upper bracket, stator frame, including other similar items.	Sa 2 1/2 - 3	Prime coat : 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	The pure metallic zinc shall be at least 92% of the polymerized film
			Intermediate Coat: 2 x micaceous iron oxide paint, 2-component Base : epoxy resin	2 x 75	This paint system is for temperatures up to 120°C
			Finish Coat : 1 x topcoat, 2-component Base : epoxy resin	1 x 50	
			Total	250	



ANNEX-1

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Volume IIA (GTS)

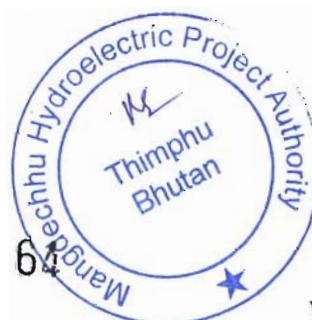
PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
D	Control panels / cubicles, switch gear panels and other panels / cubicles except marshalling kiosks etc.	Sa 2 1/2 - 3 and de-grease before painting or any other equivalent process.	Prime coat : All enclosures, frames, bottom cover etc., should be dip coat primed or zinc plated and passivated for corrosion resistance or equivalent.	20-25	Finally to be approved at design stage
			Finish Coat; Texture powder coating or equivalent as per approved color code on interior and exterior surface	> 70	Finally to be approved at design stage
			Total	> 95	

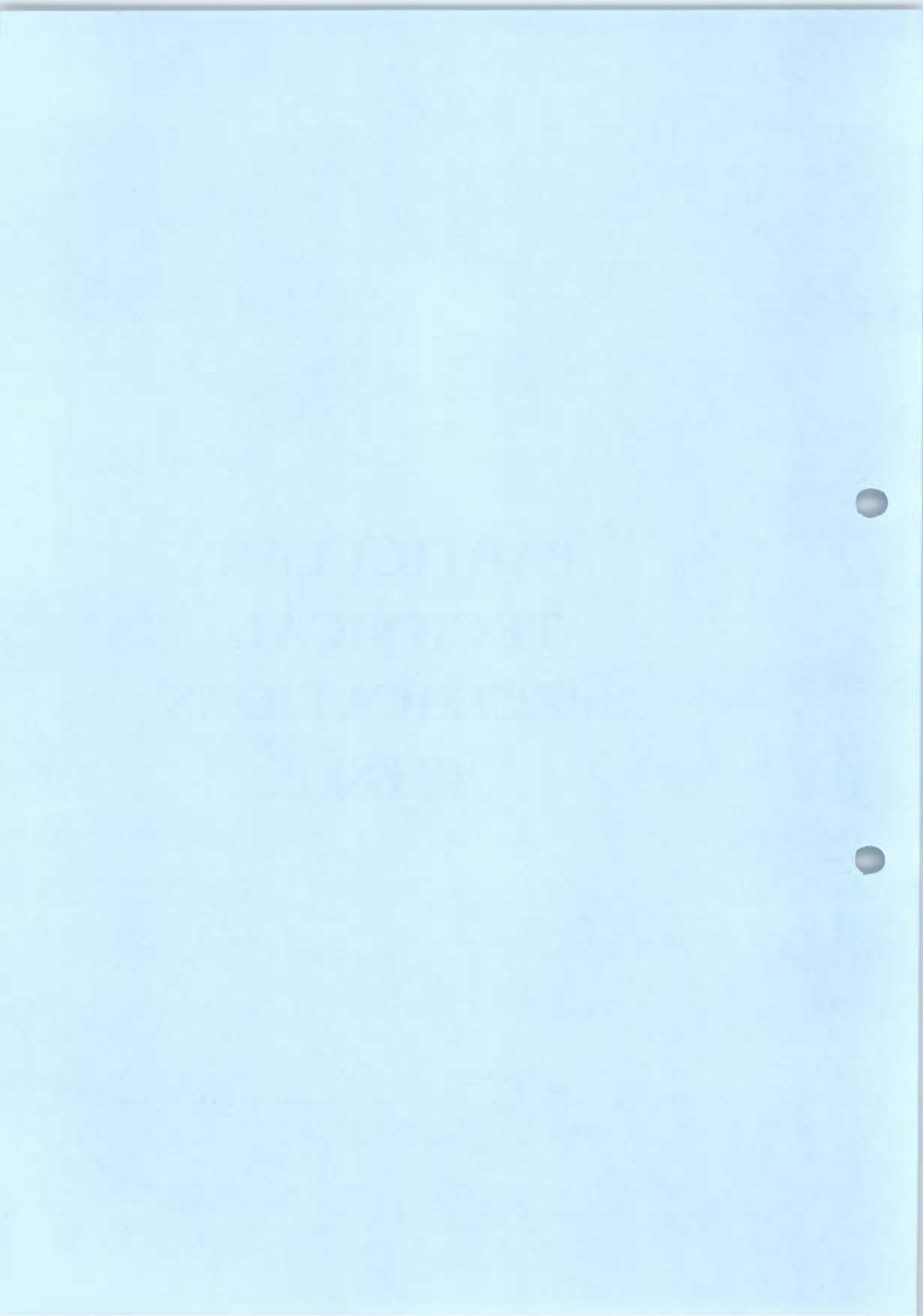


PAINTING SYSTEM

Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
E	Interior surfaces of oil and air tanks such as bearing oil tank, accumulator, sump tank, air tank and other similar items	Sa 2 1/2 – 3	Prime coat : 1 x epoxy iron oxide or equivalent	*	* To be decided during detailed engineering
			Finish Coat : 1 x polyurethane or equivalent		



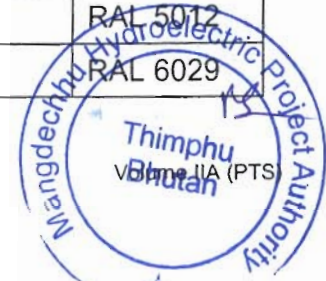
**PARTICULAR
TECHNICAL
SPECIFICATIONS
(PTS)**



ANNEXURE

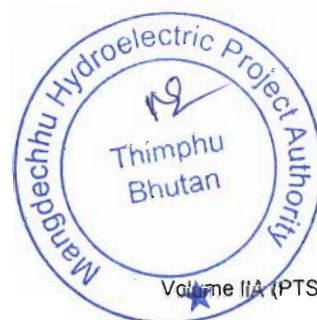
STANDARD PAINTING SCHEDULE/ COLOUR GUIDELINES

SI. NO.	DESIGNATION	COLOUR	REF. COLOUR
1	EOT Crane	Yellow	RAL 1004
2	EOT Crane Power Supply Box	Pearl White	RAL 1013
3	Governor Cubicle	Pearl White	RAL 1013
4	Main inlet valve	Green	RAL 6029
5	LCC For Governor / MIV OPU	Pearl White	RAL 1013
6	Generator Top Cover	Pearl White	RAL 1013
7	LAVT / NGT / Transformers	Grey	RAL 7035
8	Bus Duct	Grey	RAL 7035
9	Brake Dust Collector	Grey	RAL 7035
10	Braking Air Tank / Control Cubicle	Grey	RAL 7035
11	HS Oil Unit	Grey	RAL 7035
12	Oil Sump Tank	Grey	RAL 7035
13	Oil Pressure Tank	Orange	RAL 2000
14	Cooling water Pump, Filters, Cyclone separators etc.	Green	RAL 6029
15	LCC For Cooling Water System	Pearl White	RAL 1013
16	Fire Fighting Pump , Filters	Red	RAL 3000
17	LCC For Fire Fighting Pumps	Pearl White With Fire Red Brand	RAL 1013
18	HP Compressed air system Compressor / Dryer / Tank	Blue	RAL 5015
19	Oil purifying system (Tank, Pumps etc.)	Orange	RAL 2000
20	LCC for Drainage & Dewatering	Pearl White	RAL 1013
21	Oil Piping	Orange	RAL 2000
22	Air Piping	Blue	RAL 5012
23	Water Piping	Green	RAL 6029



SI. NO.	DESIGNATION	COLOUR	REF. COLOUR
24	GIS Bay	Grey	RAL 7038
25	GIB	Grey	RAL 7038
26	LCC for GIS	Pearl White	RAL 1013
27	DG Panels	Pearl White	RAL 1013
28	DC Boards, Invertors, Charger	Grey	RAL 7035
29	Main Terminal Box	Grey	RAL 7035
30	Illumination Board	Grey	RAL 7035
31	Low Voltage Boards, Distribution Boxes, Starter Panels Etc.	Melon Yellow	RAL 1028
32	UCB / UAB / SSB/ Excitation Panel / Protection Panel / Distribution etc.	Pearl White	RAL 1013
33	11kV Switchgear	Grey	RAL 7035
34	Elevator	Stainless Steel	

Note:- Colour schedule mentioned on the relevant drawings of the equipment shall be reconfirmed from Employer during detail engineering.



11 CONTROL AND MONITORING SYSTEM

11.1 Scope of Work

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance and acceptance testing, training of Employer's personnel, handing over to MHPA and guarantee for two years of control and monitoring system as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system complete in every respect including but not be limited to following:

11.1.1 Local control boards

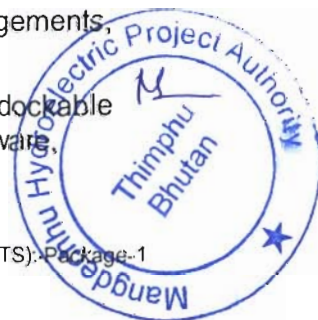
The Computerized Control and Monitoring System shall contain at least the following Local Control Boards:

- i) Four (4) sets of Unit Control Boards (UCB) with all necessary accessories,
- ii) One (1) set of LCB for Common, Station Services, Dam monitoring and BFV control with all necessary accessories,
- iii) One (1) set of LCB for Electrical Power Supply Service Boards with all necessary accessories for complete 33KV switchgear & feeders, 11kV switchgears & feeders, DG sets, Auxiliary Power Transformer, Station auxiliary Transformers, Unit Tap-off Transformers, Pothead yard Transformer, Valve House Transformer and 415 V switchgear,
- iv) One (1) set of LCB for 420 kV GIS Control Boards with all necessary accessories.

11.1.2 Central Control Centre

Central Control Centre shall comprise of the following equipment:

- i) Two (2) Operator Workstations each with two sets of LED backlit monitors and all necessary accessories and software,
- ii) One (1) Fixed Engineering station with all necessary accessories and software,
- iii) One (1) Portable Engineering station with dockable arrangements, printer, all necessary accessories and software,
- iv) One (1) Portable Operator Workstation with dockable arrangements, printer, all necessary accessories and software.



- v) One (1) Large Screen LED based display wall with display controller acting as a video mimic,
- vi) Emergency shutdown systems one for each individual unit,
- vii) One (1) Emergency shutdown system for the entire station,
- viii) One (1) set of router/gateway with necessary firewall functionality interfaces, accessories and terminal units etc. for communication between power house and remote distant end,
- ix) One (1) set of router/gateway with necessary firewall functionality for Data transmission to Load Despatch Centre through OPGW,
- x) One (1) set of router/gateway with necessary firewall functionality for Data transmission to Administrative Buildings at Powerhouse colony and dam Colony through ADSS Cable,
- xi) Data Acquisition System (DAS) / Data logger system comprising of two (2) nos. of high-capacity Network Attached Storage systems (one main + one hot standby),
- xii) One (1) Training simulator, with all necessary accessories, software along with at least 5 user licenses, implemented on separate workstations and connected to the Central Control Room Network,
- xiii) Operating desks for Engineering Stations, Data Storage system and Operator Workstations along with 8 nos. chairs,
- xiv) Control room layout design works as per clause no. 11.5.16.

11.1.3 Process control networks & Power house LAN

- i) Fibre optic Power House LAN with all necessary accessories and interfaces,
- ii) Fibre optic Central Control Room Network with all necessary accessories and interfaces,
- iii) Fibre optic Plant Control Network with all necessary accessories and interfaces,
- iv) Six (6) Plant Computers, Two (2) servers and Two (2) printers with all necessary accessories and software hooked up with Power House LAN.
- v) Two (2) Computers (to be installed at Administrative Buildings at Power house Colony and Dam Colony), with all necessary accessories and software hooked up with Power House LAN through ADSS optical fibre cable.

11.1.4 All Dielectric Self Supporting (ADSS) optical fibre cable

All Dielectric Self Supporting (ADSS) optical fibre link shall be provided between following locations:



- i) Power House and Dam (Approx 25 KM),
- ii) Power House and Butterfly Valve chamber (Approx 3 KM),
- iii) Power house to administrative building at Power House Colony (Approx 8 KM)
- iv) Extension of Power House to Dam line to administrative building at Dam colony (Approx 500 m)

The link shall be complete in all respects comprising but not limited to following:

- a) ADSS cable (minimum 12 core)
- b) RTU equipment / OLTE / FOTE and all necessary accessories including UPS, interfacing equipment etc, for real-time, dual-window single mode (DWSM) communication between above locations.
- c) Required no of Steel Poles for laying of ADSS cable
- d) All allied civil works for foundation / erection of ADSS cable

11.1.5 Software

- i) Supply of all necessary software as per the clause "Design and Construction" of this section and their license for use that are specific for this project,
- ii) Necessary routers and firewalls to prevent unauthorized access of process control networks from LAN / WAN connections including Power House LAN.

11.1.6 Time synchronization

Universal time synchronization system complete with redundant master clocks, at least six (6) nos. of slave clocks, antenna and any other instrumentation / provisions required for time synchronization of all the equipment of the control system as well as protection system equipment, with Global Positioning System (GPS), so that each piece of equipment shall be synchronized individually.

11.1.7 Interfacing services and supply

Coordination, supply of associated interfaces including transducers and integration of all plant equipment and subsystems including all auxiliaries and station services with the computerized control and monitoring (SCADA) system for complete control, real-time communication and data acquisition.



11.1.8 Miscellaneous items

- i) One set of measuring devices/ sensors for measurement of Tail Water Level and cabling from such devices/ sensors to Central Control Room.
- ii) Printers and plotters as below:
 - a) Colour Alarm printer,
 - b) Event and data logging printer,
 - c) A3 size colour hard copy printer
 - d) Two heavy duty A3 size black & white laser printers
 - e) High quality colour plotter (A0 size)
- iii) Spare parts in accordance to clause 11.8 "Spare Parts" of this section.
- iv) Tools and instruments in accordance to clause 11.9 "Tools and Instruments" of this section

Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

11.2 Specific Parameters and Layout Conditions**11.2.1 Layout and General Arrangement**

The basic configuration and general layout of the control system shall be as per drawing NH/DEM/MGD/CP/04.

All UCB and LCB panels shall be based on IP 52 class of protection for enclosure.

The control and monitoring system shall be built up of distributed and independent control modules in hierarchical control levels. All the components and subsystems in the hierarchical control levels of the control system shall be seamlessly integrated to achieve a highly reliable and scalable power plant control system.

The overall control shall be affected from the Central Control Room. The highest control level shall be the Operator Workstations in the Central Control Room (CCR). From the Operator Workstations, the operator shall have the possibility to perform in real-time, controls and adjustments for all the equipment of the scheme.

Provision shall be kept for connection of Power Station Control and Monitoring system for Remote monitoring purpose. Provision shall be made to include the functionality of transmitting binary commands and set points of the Power stations.

All the computers, peripherals, software, actuators, sensors, measuring instruments and other hardware shall be of latest state of the art at the



time of supply. If the control system mentioned in the awarded contract becomes obsolete at the time of supply, the Contractor shall offer a latest model.

The control system should be built in such a way that in case of a fault in any single equipment others are not affected and system continues to function effectively.

The control system shall be designed on open standards based on IEC 60870-5 series and Object Linking and Embedding for process control (OPC) standards. Control & Monitoring System design should be robust to address the high humidity, high temperature variations and importance should be given while selecting the field instrumentations. The control and monitoring system and the components shall be selected taking the following requirements into consideration:

- i) Reliability of components and subsystems,
- ii) Scalability of the system for future extensions,
- iii) Backward compatibility and Interoperability with other sub-systems including multi-vendor platforms
- iv) Availability of spares,
- v) Ease of maintenance,
- vi) Service availability and adaptability for future technology developments,

11.2.2 Networking and communications

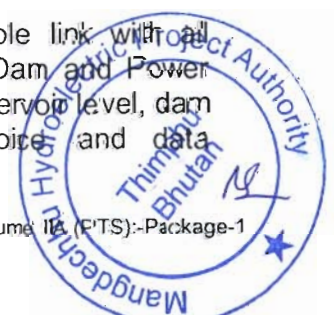
All the optical fibre cabling within the power house shall be armoured type suitable for laying directly on the cable trays. All redundant cables shall be physically routed along different paths so as to ensure higher availabilities. The networks shall be designed for 1Gbps, real time and full duplex (bi-directional) communications.

All networks shall be configured to form a dual star topology with switched based Ethernet. The networks shall be designed with triple fault redundancy.

The switches will detect and, without manual intervention, provide alternate paths in the event of loss of communication at at-least two places. The double redundant switches shall be able to detect and compensate for the failures of other switches, cable disruptions or hardware failure of one or more ports.

Process control networks shall be separated from Power House LAN by suitable firewalls to restrict access to the control system. All RTU data communications shall be encrypted.

All Dielectric Self Supporting (ADSS) optical fibre cable link with all interfaces and accessories shall be provided between Dam and Power house. The link shall be used for remote monitoring of reservoir level, dam site equipment etc. and shall be suitable for voice and data



communications also. The link shall be suitable for voice and data communications also.

Necessary provision shall be kept in the optical fibre link for future interconnection of communication system of Power house to that of DAM.

All Dielectric Self Supporting (ADSS) optical fibre cable link with all interfaces and accessories shall be provided for between valve house and Power house. The link shall be used for control of butterfly valve equipment and shall be suitable for voice and data communications also. The optical fibre link may also be used for interconnection of communication network of Power house to that of Valve house.

11.2.2.1 Network Switches for Networking and communications

The network Ethernet switches shall be selected taking following requirements into consideration:

- 1) The network switches shall be able to configure and diagnose via SNMP (Simple Network Management Protocol), via WBM (Web Based Management) and via serial interface (Hyper Terminal).
- 2) The network switches shall have redundant power supply voltage connection, floating alarm contact, status and diagnostic indicators, pluggable and configurable parameterization memory, din rail mountable, auto-crossing, auto-negotiation as minimum acceptable features to ensure easy maintenance as and when required.
- 3) The network switches shall have Gigabit Ethernet on all ports.
- 4) The network switches shall be only Industrial Grade and in conformance with EMC directives in accordance with IEC 61000 with following parameters as below:
 - i) Noise immunity in accordance with IEC 61000-4-2 (ESD)
 - ii) Noise immunity in accordance with IEC 61000-4-3 (electromagnetic fields)
 - iii) Noise immunity in accordance with IEC 61000-4-4 (Burst)
 - iv) Noise immunity in accordance with IEC 61000-4-5 (Surge)
 - v) Noise immunity in accordance with IEC 61000-4-6 (conducted)
- 5) The network Switches shall be in conformance with following Mechanical Tests as below:
 - i) Shock test according to IEC 60068-2-27
 - ii) Vibration resistance according to IEC 60068-2-27
 - iii) Free fall according IEC 60068-2-32
- 6) The fibre optic ports of the network switches shall be in SFP (Small Form Pluggable) format so that both multi-mode and single mode glass fibres can be used as per transmission distances in the network.

11.2.2.2 Network Security

The network equipments shall have a high level of security features in order to prevent any kind of external intrusion/hacking event into the system. The security parameter shall include port security, both Multiple IP and Multiple MAC addresses, blocking of unused port, disabling/enabling of Web manager and Telnet, Multilevel user password to secure the switch and alarming or warning system in case of fault in the network.

11.2.3 Interoperability

The complete design of the computerized control and monitoring system shall be based on interoperability of equipment from different manufacturers and the Contractor shall be responsible for overall functional integration of the system. The control system shall be implemented on open standards based on Object oriented design.

It shall be the responsibility of the Contractor to verify and solve all interoperability issues of various components / equipment connected to the network. The Contractor shall perform a type conformance test to validate the implementation of the communication protocols.

11.2.4 Redundancy

The control system shall have both physical and functional or operational redundancies. All the control system should have suitable rating of surge protection device at functional level. These arresters should be pluggable type and should have fault indication. At least the following physical redundancies shall be ensured in the design of the control and monitoring system:

- i) Redundancy of communication media shall be through redundant optical fibre cables,
- ii) Operator station redundancy shall be ensured by mirror images of process data on all the two operator workstations,
- iii) Networking redundancy shall be implemented by using redundancy of servers, routers and switches in dual star with triple fault redundancy. All networks including Power House LAN shall be redundant.
- iv) All Controllers and their power supply distribution cards used in LCBs/UCBs shall be redundant,
- v) Event and Alarm printers shall be configured to take over the duties of each other in the event of failure of any one of them,
- vi) The unit shut down system shall include emergency shut down system implemented by hard wired logic.



- vii) The database storage system shall be redundant and implemented through at least two Network attached storage devices.
- viii) The GPS synchronization master clocks shall be redundant.

11.2.5 Laying of ADSS Optical fibre cable

A) For Power House to Dam

The ADSS cable from Power house to Dam shall be laid on poles of existing 33 KV line, which is connected between Yurmoo substation & Kewathang substation and passing through the close vicinity of Pot yard as well as Dam. For laying the ADSS cable from last pole at DAM to DAM control room, the route / arrangement shall be decided during detail engineering. Laying of ADSS cable from last pole at pot yard to Power house control room may be done through cable tunnel suitable arrangement which shall be finalised during detail engineering.

The spans of the existing 33 KV lines are in the range of 45 m to 150 m and also there are some road crossing of the lines. Accordingly, the detail survey of the route of 33 KV line shall be done by the contractor in order to establish the technical feasibility of the installation of ADSS cable. Some additional poles (minimum 10 m height) may also be required for providing requisite support to the ADSS cable. Also some existing poles may require additional strengthening for support of ADSS cable. The ADSS cable shall have adequate mechanical strength to get the required tension during installation without compromising the ground clearance requirement.

The existing 33kV will be in charged condition for providing construction power to various project sites and taking longer shutdown of the line for installation of ADSS cable may not be feasible. The Contractor has to plan accordingly for installation of ADSS cable on the poles of live 33 KV line and shall ensure appropriate safety measure including use of safety gears for their working personnel at site.

B) For Power House to Valve house

ADSS cable from Power house to Butterfly valve house chamber shall be laid on poles of 11 KV line, described under "Section-14, MV switchgear & Auxiliary transformers". For extension of ADSS cable inside the cavern, the route / arrangement shall be finalised during detail engineering.

C) For Power House to administrative building at Power House colony

For monitoring of power house & dam data from administrative building at Power house colony, necessary link at Power House colony is required to be provided through ADSS cable. The ADSS cable shall be laid through existing 33 KV line from near Power House to Administrative building at Power House colony which is approx 8 Km distant.

The conditions for laying of the cable shall be as described above. The details of route / arrangements shall be finalised during detail engineering.

D) For Extension of Power House to Dam line to administrative building at Dam colony

For monitoring of power house & dam data from administrative building at Dam colony, necessary link at Dam colony is required to be provided through ADSS cable. The proposed route of ADSS link from power house to Dam is passing from close vicinity of Dam colony and the same link shall be extended to the administrative building at Dam colony through dedicated network / poles which is approx 500 m distant. The minimum height of poles shall be 10M.

The conditions for laying of the cable shall be as described above. The details of route / arrangements shall be finalised during detail engineering.

11.2.6 Communication through Optical Ground Wire (OPGW)

All necessary works including supply / laying of armoured underground fibre optic cable (required from pothead yard to appropriate location in the underground power house) and fibre splicing / terminations at the FOTEs/ OLTEs at the pothead yard shall be included in the Contracts. However, supply of OPGW and their termination equipments (FOTE/ OLTE) at the pothead yard is not in the Contractor's scope.

11.3 Rating and Functional Characteristics

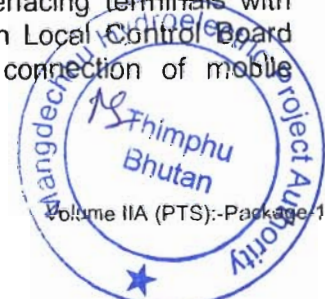
11.3.1 Topology, redundancy and availability

The networks shall be configured using redundancy of servers, routers and switches, in dual star switched Ethernet topology with triple fault redundancy, to achieve high operational availabilities for top order events. The system availability shall analyse and calculations shall focus on availability of the control system for the top order event: "Availability to retrieve all process data from LCBs and operate all breakers and shut down all units". The overall system unavailability shall be computed by considering individual device unavailability in a fault tree analysis using MTTR, MTTF and MTBF values of each device as supplied by its manufacturer.

11.3.2 Decentralised Control

The instrumentation and control system shall be based on the decentralized intelligence system, which means that Controllers of the corresponding system operates the logic and control functions.

The control system shall be divided into discrete functional subsystems. Each sub-system shall be controlled from its Local Control Board if the "LOCAL" position is selected. The Local Control Board of each system includes redundant power supply distribution, interfacing terminals with the process, redundant controllers and HMI. Each Local Control Board shall have provisions and interfaces for direct connection of mobile engineering stations.



The Unit control Board and Local control board must be provided with surge protection device. The surge protection device shall be tested with IEC 61643-1. The surge arrester should be pluggable type and should have indication for life.

The Local Control Boards associated with switchyards and generating units (Unit Control Boards) shall, in addition to the above, consist of automatic and manual synchronizers.

11.3.3 Computers and peripherals

Computers used in the control and monitoring system shall preferably be of a standardized type suitable for industrial environments and of a brand approved by the Employer. The signal transmission shall be via redundant fibre optic cables. All shall be of Full HD resolution, flicker free LED backlit type with at least 22" screen size. All keyboards / functional keyboards / keypads to be supplied except those in offices and on Power House LAN shall be membrane protected. All Computers, printers and other accessories supplied shall be of robust and tropicalized type of construction so as to withstand Hydro power plant environmental conditions.

The Monitors for the Computers to be installed at Administrative Buildings of Power house Colony and Dam Colony shall be of Full HD resolution, flicker free LED backlit type with at least 50" screen size.

11.3.4 Power supply for Local Control Boards

Power supply for control of all Local Control Boards shall be 220 V DC. Each LCB shall be fed from two independent power supplies for control function. One power supply shall be main and other standby. In case of failure of main supply, standby supply shall be switched on automatically.

Power supply converters / units / modules provided in the UCBs / LCBs shall be 100% redundant. In case A.C. supply is used for any control function two on-line station UPS, with one as standby, powered by 220 V DC system shall be provided.

Both the AC and DC Power supply inputs for the local control boards shall be protected at the input by Class C type pluggable and testable Surge Protection Devices.

11.3.5 Programmable controllers for LCBs and UCBs

The programmable controllers / PLCs to be supplied shall be modular in architecture and microprocessor based design suitable for harsh industrial environments. All power supply cards, I/O module connections and other external interfaces shall be provided with suitable surge protection devices to protect the controllers and internal circuitry from external surges. The surge arrester should be tested as per IEC 61643. The Surge arrester should be pluggable type and should have failure indication. All power supply cards, I/O module connections and other external interfaces

shall be provided with suitable DIN rail mountable, pluggable and testable surge protection devices in accordance with IEC 61643 test standards to protect the controllers and internal circuitry from external surges. Unless otherwise specified, the equipment shall be in compliance with IEC 61131 standard.

All PLC units used in the control and monitoring system shall be of the same manufacturer and of the same model. Interchangeability and interoperability of PLCs used shall be established by the Contractor. The supply for PLC shall include all equipment and services for operating and maintenance, such as manufacturer's standard firmware, licensed PLC programming and debugging tools, test equipment, all software with license for use and source codes for the application programs, spare parts and full documentation along with training. Each PLC shall have long-life internal battery backup/ non-volatile memory for storing running data and programs. All software and firmware supplied must be of latest release/ version

For each output a safe position shall be defined for cases of failure of power supply, output module, CPU, etc. This safe position shall be clearly defined by the Contractor and submitted to the Employer. Each controller shall have built-in functions of on-line self diagnostics / watch dog features etc and shall report failures to the operators of the control system. The CPU shall be able to accept external time synchronization from GPS system, adjust its internal clock with the time synchronization system and then time tag data with an absolute clock.

Each I/O point of the controllers shall be supplied in standard rack-mounted I/O modules with plug-in boards. Each I/O point shall be furnished with:

- i) Protective network, such as surge protections, optical coupling and/or other isolating barriers,
- ii) Filter for noise reduction,
- iii) Test points and fault indication lamps,
- iv) Fuse protection and fuse failure detection.

11.3.6 Emergency shut down

Emergency shutdown equipment shall be implemented through hardwired logic using Safety Relays (SIL-3, IEC61508). Emergency shutdown equipment shall be implemented through hardwired logic. Emergency shutdown shall be initiated by the monitoring and protection devices as well as by manual release of the emergency shutdown buttons to be provided in the UCB and Central Control Room. The timing of emergency shutdown and associated closure devices shall be adjusted according to the hydraulic requirements of the system.



11.3.7 Metering

For monitoring the generation and transmission of power, a metering system using digital meters and recorders shall be provided for all lines and feeders of GIS / Pot yard, Generators at 13.8 kV level, Unit Tap-off Transformers, Auxiliary Power Transformer, Station Auxiliary Transformers and DG Sets. All measurements such as voltage, current, power, energy etc., used for monitoring, shall be provided as per drawings. All the energy meters used for measurements shall have minimum accuracy of 0.2% and shall be connected to the data acquisition system for automatic meter readings. The special energy meters (SEMs), as marked in the drawing, are used for commercial purpose and hence shall be provided by load dispatch agency and only their CT cores, wiring up to GIS Local Control Board & providing enough space for installation are included in this contract. Special Energy Meters (SEMs) shall be installed at 13.8kV side of each unit which shall have the following features:

- i) Meters shall be static type and have anti-tampering features.
- ii) Meters shall be capable of four quadrant measurement of kWh, kVARh, kVAh.
- iii) Meters shall have downloading facilities of metered data through meter reading instrument (MRI).
- iv) Meters shall be immune to external influences like magnetic induction, vibration, electrostatic discharge, switching transients, surge voltages, oblique suspension and harmonics etc.
- v) Meters shall have necessary ports for communication to plant SCADA system.

11.3.8 Time resolution of events

Resolution of dating of events for purposes of sequence of event recording shall be of 1milli second.

11.4 Performance Guarantee

The computerized control and monitoring system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

The control and monitoring system shall be fault tolerant with redundancies at all levels as specified in the sub clause "Redundancy" of clause 11.2 "Specific Parameters and Layout Conditions".

The control system shall have fail safe features so that even in case of failure of all redundant controllers, the outputs shall be latched on to a safe value that ensure minimum plant safety features. The Contractor



shall identify and submit to the Employer a detailed list of these fail safe outputs along with their safe values during detailed engineering.

Real time, full duplex data transmission rate, of at least 1Gbps shall be provided. The availability of 1 Gbps data channel between two remote stations shall be greater than 99.99% and shall be guaranteed.

The Overall control and monitoring (SCADA) system availability for top order events shall be at least be 99.98% and shall be guaranteed. The control system shall be guaranteed against interoperability with all the power house equipment and shall comply with IEC 60870-5 series.

11.5 Design and Construction

11.5.1 Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Sl. No.	Standard	Description
1	IEC 60255	Electrical relays
2	IEC 60297	Dimension of mechanical structure of 19 inch series
3	IEC 60326	Printed Boards
4	IEC 60446	Basic and safety principles for man-machine interface, marking and identification, identification of conductors by colours or numerals
5	IEC 60478	Stabilized power supplies, DC output
6	IEC 60625	Interface system for programmable measuring instruments
7	IEC 61000	Electromagnetic compatibility for industrial process – measurement and control equipment
8	IEC 61131	Programmable controllers
9	IEC 61158	Digital data communications for measurement and control – Field bus for use in industrial control systems
10	ISO/IEC 8802	Information technology
11	IEEE 1046	Application guide for distributed digital control and monitoring for power stations

Sl. No.	Standard	Description
12	IEC 60870	Tele-control equipment and systems
13	IEC 60793 Part 1	Optical Fibre- Measurement and test procedures
14	IEC 60793 Part 2	Optical Fibre- Product specifications
15	IEEE 802.1W	Network Switches in Communication Networks and Systems for Power plants
16	IEC 61850	Communication Networks & Systems in Substations
17	IEC 61643-1	Surge Protection Devices

Optical Fibre Cables used shall comply with the provisions of latest ITU-T Specifications and IEC standards. The communications and networks of the control system shall be implemented on open network standards conforming to IEC 60870-5 series standards. Any design feature or detail not specified herein shall be in accordance with the above-mentioned standards, which shall supplement these specifications.

All the mimic views, software, printouts, documentation symbols, reports, labels etc. shall be in English language only.

To achieve redundancy and operational centralization, a Central Control Room shall be implemented from where all units along with all their unit auxiliaries, all Station Services, all Common Services, all switchyard and electrical power supply distribution shall be operated and supervised.

11.5.2 General

The designed control and monitoring system shall be common state of art at the time of supply. This specification requires that all local and remote control systems in the power house and the ancillary plant areas shall be suitable for manual and automatic start-up, running and normal and emergency shut-down of the generating units and the station auxiliary systems. Redundant Controllers of latest microprocessor based design with high processing speeds and solid-state electronic elements shall accomplish the control.

11.5.3 System configuration

The basic system configuration shall be as per approved scheme based on Employer's drawings. The normal turbine-generator start-up and shutdown shall be controlled automatically either from the Unit Control Boards on the machine hall floor or from the Operator Workstations in the Central Control room. Manual control shall be possible from the Unit Control Boards.

