SPECIAL CONDITION OF CONTRACT

For Plant Works

PART - I

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SPECIAL CONDITIONS OF CONTRACT

PART – 1

The following Special Conditions of Contract shall supplement the General Conditions of Contract. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions of Contract. The corresponding clause number of the General Conditions is indicated in parentheses.

Definitions (Clause 1)

(a) The Project Authority is Bihar State Milk Co-Operative Federation Limited and would include the term “Owner”.

(b) The Supplier is (Name of Supplier).

2. Country of Origin (Clause 3)

The place where the goods were mined, grown or produced from which the services are supplied.

3. Equivalency of Standards and Codes (Clause 4)

Wherever reference is made in the contract to the respective standards and codes in accordance with which goods and materials are to be furnished, and work is to be performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly set forth in the Contract. Where such standards and codes are national in character, or relate to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be accepted subject to the Purchaser’s prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Supplier and submitted to the Purchaser at least 30 days prior to the date when the Supplier desires the Purchaser’s approval. In the event the Purchaser determines that such proposed deviations do not ensure equal or higher quality, the Supplier shall comply with the standards set forth in the documents.

4.0 Performance Security (Clause 7)

4.1 The Performance Security shall be in the amount of 10% of the Contract price.

4.2 Additional Performance Security, if deemed necessary, shall be submitted as mutually agreed by the Purchaser and the successful bidder at the time of acceptance of the contract/Purchase order.

5.0 Inspection and Tests (Clause 8)

5.1 The inspection of the Goods shall be carried out to check whether the Goods are in conformity with the technical specifications attached to the purchase order form and shall be in line with the inspection/test procedures laid down in the Schedule of Specifications and the Contract conditions.

5.2 Manufacturer must have suitable facilities at their works for carrying out various performance tests on the equipment. The bidder should clearly confirm that all the facilities exist for inspection and shall be made available to the inspecting Authority.

5.3 A load and functional tests as indicated in the specifications must be carried out at the manufacturer’s works. Reliability of the equipment shall be demonstrated to the satisfaction of the appointed inspector or inspecting Agency.
5.4 Approved supplier’s drawings shall not be departed from except as provided in the Bidding Document.

5.5 The Purchaser shall have the right at all reasonable times to inspect, at the Supplier’s premises all Supplier’s drawings of any part of the work.

5.6 The supplier shall provide, within the time stated in the contract or in the programme, drawings showing how the plant is to be designed and any other information required for-
   a) Preparing suitable foundations or other means of support.
   b) Providing suitable access on the site for the plant and any necessary equipment to the place where the plant is to be erected and
   c) Making necessary electrical connections from the panel board provided in the individual sections to the machines

5.7 Before the goods and equipment are taken over by the Purchaser, the Supplier shall supply operation and maintenance manuals together with drawings of the goods and equipment as built. These shall be in such details as will enable the Purchaser to operate, maintain, adjust and repair all parts of the works as stated in the specifications.

    The manuals and drawings shall be in the ruling language (English) and in such form and numbers as stated in the contract

    Unless and otherwise agreed, the goods and equipment shall not be considered to be completed for the purposes of taking over until such manuals and drawings have been supplied to the Purchaser.

5.8 The goods will be accepted after inspection by the Purchaser, his representative or any inspection agency appointed by Purchaser and the costs for such Inspector/Agency shall be borne by the Purchaser.

6. Delivery and Documents (Clause 10)

    Upon shipment/dispatch, the supplier shall notify to the Purchaser by cable or email or fax the full details of dispatch including Purchaser order no., description of the goods, quantity, mode of transport, place of loading, date of dispatch etc. The supplier will mail the following documents to the Purchaser with a copy to the Insurance Company:

    The Supplier's invoice showing purchase order no. Goods description, quantity, unit price, total amount;

    Delivery note/case-wise detailed packing list identifying contents of each package/lorry receipt;

    Manufacturer's/Supplier's guarantee certificate;

    Inspection Certificate issued by the nominated inspection agency, and the Supplier’s factory inspection report;

    Certificate of origin;

    Insurance policy;

    Excise gate pass / octroi receipts wherever applicable, duly sealed indicating payments made; and

    Any other document evidencing payment of statutory levies.

The supplier’s certificate certifying that the defects pointed out during inspection have been rectified.
Note: The nomenclature used for the item description in the invoice/s, packing list/s and delivery note/s etc. Should be identical to that used in the purchase order. The dispatch particulars including name of transporter, LR no. And date should also be mentioned in the invoice/s.

7. Insurance (clause 11)

The “marine / transit” insurance to be taken by the contractor / supplier shall be in an amount equal to 110% of the FOR Destination value of the goods from “warehouse to warehouse” on “All Risks” basis including Strike, Natural calamities but exclusive of War Risks valid for a period not less than 3 months after the date of arrival of Goods at final destination “Storage-cum-erection ALL Risks” insurance for an amount equal to 110% of the contract value valid for a period not less than 3 months after installation, including one month for testing and commissioning, shall be taken by the contractor / supplier.

OR

As an alternative to (a) & (b) above, “Marine-cum-erection ALL Risks” insurance policy, covering storage of equipment and other erection materials at site, for an amount equal to 110% of the contract value of supply, installation & commissioning and valid for a period not less than 3 months after installation, including one month for testing and commissioning, shall be taken by the contractor / supplier.

(c) Third Party Insurance : Before commencing the erection work the contractor / supplier without limiting his obligations and responsibilities, shall insure against his liability for any material or physical damage, loss or injury which may occur to any property including that of the Owner / Purchaser, or to any person including any employee of the Owner / Purchaser.

Such insurances shall be for an amount not less than Rs. 10.00 lakhs per occurrence with the number of occurrence limited to five.

8. Incidental services (Clause 12)

8.1 The incidental services for supply, installation and commissioning contract, as follows shall be provided by the Supplier:

(a) Furnishing of tools required for assembly and maintenance of the supplied goods;
(b) Furnishing of a detailed operations and maintenance manual for each appropriate unit of the supplied Goods;
(c) On-site assembly and start-up of the supplied Goods;
(d) Conduct of training of the Purchaser’s personnel (approx. for 4 man-weeks); at the Supplier’s plant and/or on-site, in assembly, start-up operation, maintenance and/or repair of the supplied Goods.
(e) Furnishing of layout drawing etc. as specified in clause 3 of Special Conditions of Contract Part II.

9. Spare Parts (Clause 13)

Supplier shall carry sufficient inventories to assure ex-spare parts and components shall be supplied as promptly as possible but in any case within six months of placement of order.

10. Warranty/Guarantee (Clause 14)

The warranty/guarantee shall be as per provision under Clause 14 of General Conditions.

11.0 Payment (Clause 15)

11.1.1 Payment for design and supply component:
a) 30% (Thirty Percent) of the total supply may be paid in advance against Bank Guarantee of the equivalent amount valid till completion of the project work.

(b) On receipt of goods: 60% of the contract price of the goods (against detailed break up cost to be furnished by the Supplier in advance and accepted by the Purchaser) on safe receipt of goods at destination/site within 30 days after inspection and approval of the Purchaser.

(c) On final acceptance:

The balance 10% of the contract price of the goods shall be paid on continuous satisfactory running of the complete plant for one month, on completion of other contracted services and accepted by the Purchaser's representative, within the scope of this contract.

11.1.2 Payment for installation, testing and commissioning component:

(a) On progress of work: 80% of the contract price for installation and commissioning shall be paid on prorate basis on actual completion of installation/erection and after due inspection and approval by the Purchaser (against detailed break up cost to be furnished by the Supplier in advance and accepted by the Purchaser).

(b) On commissioning: 10% of the contract price for installation and commissioning shall be paid on actual completion of commissioning and after due inspection and approval by the Purchaser (against detailed break up cost to be furnished by the Supplier in advance and accepted by the Purchaser).

(c) On final acceptance:

The balance 10% shall be paid on continuous satisfactory running of the complete plant for one month, on completion of other contracted services and accepted by the Purchaser's representative, within the scope of this contract.

NOTE:

(i) All bank guarantees should be issued by Nationalized Banks/other banks like IDBI Bank treated/approved by RBI to be at par with Nationalized Banks for the limited purpose of acceptance of guarantee.

(ii) The successful bidder may raise running bills for supply as soon as supply is completed as per the schedule and bills for labour job shall be raised once in a month.

(iii) Retention money shall be deducted @ 10% of the Contract Price (excluding taxes) wherever tax break-up is available separately in the Purchase Order/Contract.

(iv) The Purchaser shall issue Material Transfer Challan (MTC) after safe receipt of equipment.

(v) No cost escalation will be granted towards the supply of Plant equipments & allied accessories.

12. Resolution of Disputes (Clause 27)

In the event of any dispute in the interpretation of the terms of the order/contract or difference of opinion between the parties on any point in the order/contract arising out of or in connection with the agreement accepted order/contract or with regard to performance of any obligation hereunder by either party, the parties hereto shall use their best efforts to settle such disputes or difference of opinion amicably by mutual negotiations. In case no agreement is reached, either party may forthwith give to the other, a notice in writing of the existence of such question, dispute or difference of opinion and the same shall be referred to the adjudication of sole arbitrator to be appointed by Purchaser whose decision in the matter shall be final and binding on the parties.

The Arbitration proceedings shall be governed under the provisions of the Indian Arbitration and Conciliation Act, 1996 and the rules there under or any statutory modifications thereof for the time being in force. In the order/contract, the venue of such Arbitration shall be
Patna, Bihar and Courts at Patna alone shall have jurisdiction regarding any matter arising out of order/contract.

Performance under the Contract shall, if reasonably possible, continue during the Arbitration proceedings and payments due to the Supplier by the Purchaser shall not be withheld, unless they are the subjects of the Arbitration proceedings.

All awards for claims equivalent to Rupees thirty thousand or more shall be in writing and state the reasons for the amounts awarded.

13 Notices (Clause 30)

For the purpose of all the notices, the following shall be the address of the Purchaser and Supplier.

Purchaser – Bihar State Milk Co-Operative Federation Limited, Patna-800014

Supplier (To be filled in at the time of Contract signature.)
## SPECIAL CONDITIONS OF CONTRACT FOR ERECTION

### PART – II

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1.0 SUFFICIENCY OF TENDER

The Supplier by bidding shall be deemed to have satisfied himself as to all the conditions and circumstances affecting the Contract Price, as to the possibility of executing the works as shown and described in the Contract, as to the general circumstances at the site of the works, as to the general labour position at site and to have determined the prices accordingly.

2.0 PROGRAMME OF INSTALLATION AND COMMISSIONING

As soon as practicable after the acceptance of the bid, the Supplier shall submit to the Purchaser for his approval a comprehensive programme in the form of PERT network/bar chart and any other form as may be required by the Purchaser showing the sequence of order in which the Supplier proposes to carry-out the works including the design, manufacture, delivery to site, erection and commissioning thereof. After submission to and approval by the Purchaser of such programme, the supplier shall adhere to the sequence of order and method stated therein. The submission to and approval by the Purchaser of such programme shall not relieve the Supplier of any of his duties or responsibilities under the Contract. The programme approved by the Purchaser shall form the basis of evaluating the pace of all works to be performed by the supplier.

3.0 PREPARATION OF DRAWINGS FOR APPROVAL

The Supplier should visit the site to acquaint himself in respect of existing site conditions and to know the details/information required for understanding the nature and type of civil construction works involved in the project. The Supplier shall submit to the Purchaser for approval:

a. Within the time given in the specification or in the program, such drawings, samples, patterns and models as may be called for therein, and in numbers therein required.

b. During the progress of works and within such reasonable times as the Purchaser may require such drawings of the general arrangement and details of the works as the Purchaser may require.

The specifications/ conditions concerning the submission of drawings by the Supplier are detailed as under:

3.1 Within four weeks from the date of receipt of the Notification of Award, Supplier shall furnish a list of all necessary drawings as briefly described below which the Supplier shall submit for approval, identifying each drawings by a serial number and descriptive title and expected date of submission. This list shall be revised and extended if necessary, during the progress of work depending on the nature of the contract also.

The Purchaser shall signify his approval or disapproval of all drawings or such drawings that would affect progress of the contract as per the agreed programme.

Brief list of drawings:

I. Equipment drawings for fabricated items.

II. Equipment layout for main feed plant, storage silo system and steam generation plant.
III. Flow diagrams for main processing plant, storage silo system and various services.

IV. Service piping layouts in production, storage silo system and service blocks.

V. Electrical cable, conduit / cable tray / cable trench layout.

VI. Other miscellaneous drawings as required for erection work.

VII. Electrical single line diagram, PCC and MCC general arrangement drawing and wiring diagrams.

VIII. Automation system scheme, controls and network diagrams.

3.2 Drawings showing fabrication details, dimensions, layouts and bill of materials submitted for approval shall be signed by responsible representative of Supplier and shall be to any one of the following sizes in accordance with Indian Standards: A0, A1, A2, A3 and A4.

3.3 All drawings shall show the following particulars in the lower right hand corner in addition to Supplier's name:

i. Name of the Purchaser.
ii. Project Title.
iii. Title of drawing.
iv. Scale.
v. Date of drawing.
vi. Drawing number.
vii. Space for Purchaser reference or drawing number.

3.4 In addition to the information provided on drawings, each drawing shall carry a revision number, date of revision and brief description of revision carried out. Whenever any revision is carried out, correspondingly revision number must be up-dated.

3.5 All dimensions on drawings shall be in metric units.

3.6 Drawings (three sets) submitted by the Supplier for approval will be checked, reviewed by the Purchaser, and comments, if any, on the same will be conveyed to the Supplier. It is the responsibility of the Supplier to incorporate correctly all the comments conveyed by the Purchaser on the Supplier's drawings. The drawings, which are approved with comments, are to be re-submitted in quadruplicate to the Purchaser for purpose of records. Such drawings will not be checked / reviewed by the Purchaser to verify whether all the comments have been incorporated by the Supplier.

If the Supplier is unable to incorporate any comments in the revised drawings, Supplier shall clearly state in his forwarding letter such non-compliance along with the valid reasons.

3.7 Drawings prepared by the Supplier and approved by the Purchaser shall be considered as a part of the specifications. However, the examination of the drawings by the Purchaser shall not relieve the Supplier of his responsibility for engineering design, workmanship, quality of materials, warranty obligations and satisfactory performance on installation covered under the contract.

3.8 If at any time before completion of the work, changes are made necessitating revision of approved drawings, the Supplier shall make such revisions and proceed in the same routine as for the original approval.

3.9 Date of submission

In the event, the drawings submitted for approval require many revisions amounting to re-drawing of the same then the date of submission of the revised drawings would be considered as the date of submission for approval. Four sets of all the drawings finally approved for fabrication / execution of works along with their soft copy in Auto CAD on a CD/DVD shall be submitted to the Purchaser.

3.10 The Supplier shall furnish to the Purchaser before the works are taken over, Operating and
Maintenance instructions together with four sets of hard & soft copy (on CD/DVD) of Drawings of the works as completed, in sufficient detail to enable the Purchaser to maintain, dismantle, reassemble and adjust all parts of the works. Unless otherwise agreed, the works shall
not be considered to be completed for the purposes of taking over until such instructions and drawings have been supplied to the Purchaser.

4.0 SUPPLIER'S SUPERINTENDENCE (AND) DEPLOYMENT OF ERECTION TEAM AND CONDUCT OF PERSONNEL

The Supplier shall employ one or more competent representatives, whose name or names shall have previously been communicated in writing to the Purchaser by the Supplier, to superintend the carrying out of the works on the site. The said representative or if more than one shall be employed, then one of such representatives shall be present on the site during all times, and any orders or instructions which the Purchaser may give to the said representative of the Supplier shall be deemed to have given to the Supplier. The said representative shall have full technical capabilities and complete administrative and financial powers to expeditiously and efficiently execute the work under the contract.

4.1 The Supplier shall, execute the works with due care and diligence within the time for completion and employ Supplier’s team comprising qualified and experienced engineers together with adequate skilled, semi-skilled and unskilled workmen in the site for carrying out the works. The Supplier shall ensure adequate workforce to keep the required pace at all times as per the schedule of completion. Supplier shall also ensure availability of competent engineers during commissioning/start up, trial runs, Operation of the plant/equipment till handing over of the plant.

4.2 The Supplier shall furnish the details of qualifications and experience of their senior supervisors and engineers assigned to the work site, including their experience in supervising erection and commissioning of plant and equipment of comparable capacity.

4.3 When the Supplier or Supplier's representative is not present on any part of the work where it may be desired to give directions in the event of emergencies, orders may be given by the Purchaser and shall be received and observed by the supervisors or foremen who may have charge of the particular part of the work in reference to which orders are given. Any such instructions, directions or notices given by the Purchaser shall be deemed to have been given to the Supplier.

4.4 The Supplier's employment records shall include any reasonable information as may be required by the Purchaser. The Supplier should also display necessary information as may be required by statutory regulations.

4.5 None of the Supplier's supervisors, engineers, or laborers may be withdrawn from the work without notice to the Purchaser and further no such withdrawals shall be made if in the opinion of the Purchaser, it will adversely affect the required pace of progress and/or the successful completion of the work.

4.6 The Purchaser shall be at liberty to object to any representative or person, skilled, semi-skilled or unskilled worker employed by the Supplier in the execution of or otherwise about the works who shall, in the opinion of the Purchaser, misconduct himself or be incompetent, or negligent or unsuitable, and the Supplier shall remove the person so objected to, upon receipt of notice in writing from the Purchaser and shall provide in that place a competent representative at Supplier’s own expense within a reasonable time.

4.7 In the execution of the works no persons other than the Supplier, sub- Supplier and their employees shall be allowed on the site except by the written permission of the Purchaser.

5.0 PURCHASER'S INSTRUCTIONS

The Purchaser may in his absolute discretion, issue from time to time drawings and/or instructions, directions and clarifications which are collectively referred to as Purchaser’s instructions in regard to:
5.1 Any additional drawing and clarifications to exhibit or illustrate details.

5.2 Variations or modifications of the design, quality or quantity of work or the additions or omissions or substitution of any work.

5.3 Any discrepancy in the drawings or between the schedule of quantities and/or specifications.

5.4 Removal from the site of any material brought there by the Supplier, which are unacceptable to the PURCHASER and the substitution of any other material thereof.

5.5 Removal and/or re-execution of any work erected by the Supplier, which are unacceptable to the Purchaser.

5.6 Dismissal from the work of any persons employed there upon who shall in the opinion of the Purchaser, misconduct himself, or be incompetent or negligent.

5.7 Opening up for inspection of any work covered up.

5.8 Amending and making good of any defects

6.0 RIGHT OF THE PURCHASER

6.1 Right to direct works:

6.1.1 The Purchaser shall have the right to direct the manner in which all works under this Contract shall be conducted, in so far as it may be necessary to secure the safe and proper progress and specified quality of the works. All work shall be done and all materials shall be furnished to the satisfaction and approval of the Purchaser.

6.1.2 Whenever in the opinion of the Purchaser, the Supplier has made marked departures from the schedule of completion or when circumstances or requirement force such a departure from the said schedule, the Purchaser, in order to ensure compliance with the schedule, shall direct the order, pace and method of conducting the work, which shall be adhered to by the Supplier.

6.1.3 If in the judgment of the Purchaser, it becomes necessary at any time to accelerate the overall pace of the plant erection work, the Supplier, when directed by Purchaser, shall cease work at any particular point and transfer Supplier's men to such other point or points and execute such works, as may be directed by the Purchaser and at the discretion of the Purchaser.

6.2 Right to order modifications of methods and equipment

If at any time the Supplier's methods, materials or equipment appear to the Purchaser to be unsafe, inefficient or inadequate for securing the safety of workmen or the public, the quality of work or the rate of progress required, the Purchaser may direct the Supplier to ensure safety, and increase their efficiency and adequacy and the Supplier shall promptly comply with such directives. If at any time the Supplier's working force and equipment are inadequate in the opinion of the Purchaser, for securing the necessary progress as stipulated, the Supplier shall if so directed, increase the working force and equipment to such an extent as to give reasonable assurance of compliance with the schedule of completion. The absence of such demands from the Purchaser shall not relieve the Supplier of Supplier's obligations to secure the quality, the safe conducting of the work and the rate of progress required by the contract. The Supplier alone shall be and remain liable and responsible for the safety, efficiency and adequacy of Supplier’s methods, materials, working force and equipment, irrespective of whether or not the Supplier makes any changes as a result of any order or orders received from the Purchaser.
6.3 Right to inspect the work
6.3.1 The Purchaser's representative shall be given full assistance in the form of the necessary tools, instruments, equipment and qualified operators to facilitate inspection.
6.3.2 The Purchaser reserves the right to call for the original test certificates for all the materials used in the erection work.
6.3.3 In the event the Purchaser's inspection reveals poor quality of work/materials, the Purchaser shall be at liberty to specify additional inspection procedures if required, to ascertain Supplier's compliance with the specifications of erection work.
6.3.4 Even though inspection is carried out by the Purchaser or Purchaser's representatives, such inspection shall not, however, relieve the Supplier of any or all responsibilities as per the contract, nor prejudice any claim, right or privilege which the Purchaser may have because of the use of defective or unsatisfactory materials or bad workmanship.

7.0 SUPPLIER'S FUNCTIONS
7.1 The Supplier shall provide everything necessary for proper execution of the works, according to the drawings, schedule of quantities and specifications taken together whether the same may or may not be particularly shown or described therein, provided that the same can reasonably be inferred there from and if the Supplier finds any discrepancy therein, Supplier shall immediately refer the same to the Purchaser whose decision shall be final and binding on the Supplier.
7.2 The Supplier shall proceed with the work to be performed under this Contract in the best and workman-like manner by engaging qualified and efficient workers and finish the work in strict conformance with the drawings and specifications and any changes/modifications thereof made by the Purchaser.

7.3 VARIATIONS
7.3.1.1 The Purchaser shall make any variation of the form, quality or quantity of the Works or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion be desirable, he shall have power to order the Supplier to do and the Supplier shall do any of the following:

a. Increase or decrease the quantity of any work included in the contract,
b. Omit any such work,
c. Change the character or quality or kind of any such work,
d. Change the levels, lines, position and dimensions of any part of the works, and
e. Execute additional work of any kind necessary for the completion of the works and no such variation shall in any way vitiate or invalidate the contract, but the value, if any, of all such variations shall be taken into account in ascertaining the amount of the Contract price.

7.3.1.2 No such variations shall be made by the Supplier without an order in writing of the Purchaser. Provided that no order in writing shall be required for increase or decrease in the quantity of any work where such increase or decrease is not the result of an order given under this clause, but is the result of the quantities exceeding or being less than those stated in the Contract/Bill of Quantities. Provided further that if the Supplier shall within seven days confirm in writing to the Purchaser and such confirmation shall not be contradicted in writing by the Purchaser within 14 days, it shall be deemed to be an order in writing by the Purchaser.

7.3.2.1 All extra or additional work done or work omitted by order of the Purchaser shall be valued at the rates and prices set out in the contract if in the opinion of the Purchaser, the same shall be applicable. If the contract does not contain any rates or prices applicable to the extra or additional work, then suitable rates or prices shall be agreed upon between the Purchaser and the Supplier. In the event of disagreement the Purchaser shall fix such rates or prices as shall, in his opinion, be reasonable and proper.
7.3.2.2 Provided that if the nature or amount of any omission or addition relative to the nature or amount of the whole of the works or to any part thereof shall be such that, in the opinion of the Purchaser, the rate or price contained in the Contract for any item of the works is, by reason of such omission or addition, rendered unreasonable or inapplicable, then a suitable rate or price shall be agreed upon between the Purchaser and the Supplier. In the event of disagreement the Purchaser shall fix such other rate or price as shall, in his opinion, be reasonable and proper having regard to the circumstances.

Provided also that no increase or decrease under sub-clause 7.3.2.1 of this clause or variation of rate or price under sub-clause 7.3.2.2 of this clause shall be made unless, as soon after the date of the order as is practicable and, in the case of extra or additional work, before the commencement of the work or as soon thereafter as is practicable, notice shall have been given in writing:

a. By the Supplier to the Purchaser of his intention to claim extra payment or a varied rate or price, or

b. By the Purchaser to the Supplier of his intention to vary a rate or price.

7.3.2.3 If, on certified completion of the whole of the works, it shall be found that a reduction or increase greater than 15 per cent of the sum named in the Letter of Acceptance results from the aggregate effect of all Variation Orders but not from any other cause, the amount of the Contract Price shall be adjusted by such sum as may be agreed between the Supplier and the Purchaser or, failing agreement, fixed by the Purchaser having regard to all material and relevant factors, including the Supplier's site and general overhead costs of the contract.

7.3.2.4 The Supplier shall send to the Purchaser's representative once in every month an account giving particulars, as full and detailed as possible, of all claims for any additional payment to which the Supplier may consider himself entitled and of all extra or additional work ordered by the Purchaser which he has executed during the preceding month.

No final or interim claim for payment for any such work or expense will be considered which has not been included in such particulars. Provided always that the PURCHASER shall be entitled to authorize payment to be made for any such work or expense, notwithstanding the Supplier's failure to comply with this condition, if the Supplier has, at the earliest practicable opportunity, notified the Purchaser in writing that he intends to make a claim for such work.

7.4 The work shall be carried out as approved by the Purchaser or his authorized representative/s from time to time, keeping in view the overall schedule of completion of the project. The Supplier's job schedule must not disturb or interfere with Purchaser's or other Suppliers' or Contractors' schedules of day- to-day work. The Purchaser will provide all reasonable assistance for carrying out the jobs.

7.5 Night work will be permitted only with prior approval of the Purchaser. The Purchaser may also direct the Supplier to operate extra shifts over and above normal day shift to ensure completion of contract as per schedule. Adequate lighting wherever required should be provided by the Supplier at no extra cost. The Supplier should employ qualified electricians and wiremen for these facilities. In case of Supplier's failure to provide these facilities and personnel, the Purchaser has the right to arrange such facilities and personnel and to charge the cost thereof to the Supplier.

7.6 The Supplier shall, in the joint names of the Supplier and the Purchaser naming Purchaser as the beneficiary, insure the received goods and equipment and so far as reasonably practicable the Works and keep each part thereof insured for the 110% of the Contract Sum or such other value as may be mutually agreed between the Purchaser and the Supplier against all loss or damage from whatever cause arising, other than the excepted risks, from the date of shipment or the date on which it becomes the property of the
Purchaser, whichever is the earlier, until it is taken over by the Purchaser. The Supplier shall insure against the Supplier's liability in respect of any or damage occurring whilst the Supplier is on Site for the purpose of making good a defect or carrying out the Tests on Completion.

7.7 The Purchaser shall not be liable for or in respect of any damages or compensation payable at law in respect or in consequence of any accident or injury to any workman or other person in the employment of the Supplier or any sub-Supplier, save and except an accident or injury resulting from any act or default of the Purchaser, his agents, or servants. The Supplier shall indemnify and keep indemnified the Purchaser against all such damages and compensation, save and except as aforesaid and against all claims, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

7.8 The Supplier shall insure against such liability with an insurer approved by the Purchaser, which approval shall not be unreasonably withheld, and shall continue such insurance during the whole of the time that any persons are employed by him on the works shall, when required, produce to the Purchaser or Purchaser's representative such policy of insurance and the receipt for payment of the current premium.

Provided always that, in respect of any persons employed by any sub-supplier, the Supplier's obligations to ensure as aforesaid under this sub-clause shall be satisfied if the sub-supplier shall have insured against the liability in respect of such persons in such manner that the PURCHASER is indemnified under the policy, but the Supplier shall require such sub-supplier to produce to the Purchaser or Purchaser's representative, when required, such policy of insurance and the receipt for the payment of the current premium.

7.9 Whenever proper execution of the work under the Contract depends on the jobs carried out by some other supplier, in such cases the Supplier should inspect all such erection and installation jobs and report to the Purchaser regarding any defects or discrepancies. The Supplier's failure to do so shall constitute as acceptance of the other supplier's installation / jobs as fit and proper for reception of Supplier's works except those defects which may develop after execution. Supplier should also report any discrepancy between the executed work and the drawings.

The Supplier shall extend all necessary help / co-operation to other suppliers working at the site in the interest of the work.

7.10 The Supplier shall keep a check on deliveries of the Goods covered in the scope of erection work and shall advise the Purchaser well in advance regarding possible hold-up in Supplier's work due to the likely delay in delivery of such Goods to enable him to take remedial actions.

7.11 The Supplier shall be permitted to substitute equipment of equal on better performance subject to approval by the Purchaser; which approval shall not be unreasonably withheld, provided however that the Supplier establishes to the Purchaser's satisfaction that the performance of the substituted equipment is equal or better than the performance of the equipment specified in the contract and without any increase in the Contract price.

8.0 DUTIES OF THE PURCHASER VIS-A-VIS THE SUPPLIER:

8.1 The Goods, if any, to be supplied by the Purchaser for erection, testing and commissioning by the Supplier, shall be as listed in the Contract.

8.2 Necessary temporary water for carrying out the installation / testing shall be supplied at only one point within the project site by the Purchaser free of charge. All necessary distribution tapping from this point onwards shall be the Supplier's responsibility.

8.2.1 Necessary temporary power for carrying out the installation shall be arranged by the Supplier at Supplier's own cost. The necessary authorization letter will be issued by the Purchaser on written request by the Supplier.
8.2.2 If the power is provided by the Purchaser, the recovery shall be @ 0.5% of the total purchase order value (design, supply, installation, testing & commissioning). The charges will be deducted from the Supplier’s bills. However, the supplier shall supply all the items such as switchgear, cabling etc. required for getting temporary power.

8.3 The details of temporary water and power requirements shall be furnished one month in advance by the Supplier to enable the Purchaser to make timely arrangement.

8.4 If the Supplier suffers delay from failure on the part of the Purchaser to give possession of the civil works in accordance with the mutually agreed schedule, the Purchaser shall determine any extension of time to which the Supplier is entitled under Clause 21 of GCC.

9.0 SUPPLY OF TOOLS, TACKLES AND MATERIALS

The Supplier shall, at his own expense, provide all the necessary equipment, tools and tackles, haulage power, consumables necessary for effective execution and completion of the works during erection and commissioning.

10.0 PROTECTION OF PLANT

10.1 The Purchaser shall not be responsible or held liable for any damage to person or property consequent upon the use, misuse or failure of any erection tools and equipment used by the Supplier or any of Supplier's sub-suppliers even though such tools and equipment may be furnished, rented or loaned to the Supplier or any of Supplier's sub-suppliers. The acceptance and/or use of any such tools and equipment by the Supplier or Supplier's sub-supplier shall be construed to mean that the Supplier accepts all responsibility for and agrees to indemnify and save the Purchaser from any and all claims for said damages resulting from the said use, misuse or failure of such tools and equipment.

10.2 The Supplier and Supplier's sub-supplier shall be responsible, during the works, for protection of work, which has been completed by other Suppliers. Necessary care must be taken to see that the Supplier's men cause no damage to the same during the course of execution of the work.

10.3 All other works completed or in progress as well as machinery and equipment that are liable to be damaged by the Supplier's work shall be protected by the Supplier and protection shall remain and be maintained until its removal is directed by the Purchaser.

10.4 The Supplier shall effectively protect from the effects of weather and from damages or defacement and shall cover appropriately, wherever required, all the works for their complete protection.

10.5 The work shall be carried out by the Supplier without damage to any work and property adjacent to the area of Supplier's work to whomsoever it may belong and without interference with the operation of existing machines or equipment.

10.6 Adequate lighting, guarding and watching at and near all the storage handling, fabrication, pre-assembly and erection sites for properly carrying out the work and for safety and security shall be provided by the Supplier at Supplier's cost. The Supplier should adequately light the work area during nighttime also. The Supplier should also engage adequate electricians/wiremen, helper etc. to carry out and maintain these lighting facilities. If the Supplier fails in this regard, the Purchaser may provide lighting facilities as he may deem necessary and charge the cost thereof to the Supplier.

10.7 The Supplier shall take full responsibility for the care of the works or any section or portions thereof until the date stated in the taking over certificate issued in respect thereof and in case any damage or loss shall happen to any portion of the works not taken over as aforesaid, from any cause whatsoever, the same shall be made good by and at the sole cost of the Supplier and to the satisfaction of the Purchaser. The Supplier shall also be liable for any
loss of or damage to the works occasioned by the Supplier or the Supplier’s Sub-Supplier in the course of any operations carried out by the Supplier or by the Supplier's Sub-Suppliers for the purpose of completing any outstanding work or complying with the Supplier's obligations.

11.0 UNLOADING, TRANSPORTATION AND INSPECTION

11.1 The Supplier shall be required to unload all the Goods from the carriers, received at site after Supplier's team arrives at site. The Supplier shall plan in advance, based on the information received from the Purchaser, Supplier's requirement of various tools, tackles, jacks, cranes, sleepers etc. required to unload the material/equipment promptly and efficiently. The Supplier shall ensure that adequate and all measures necessary to avoid any damage whatsoever to the equipment at the time of unloading are taken. Any demurrage/detention charges incurred due to the delay in unloading the material/equipment and releasing the carriers shall be charged to the Supplier's account. The Supplier shall be responsible for receipt at site of all Goods and Supplier's equipment delivered for the purposes of the Contract.

11.2 The Supplier shall safely transport/shift the unloaded Goods and equipment to the storage area.

11.3 In case of turnkey contracts, the cost incurred on unloading of all the Goods received by the Purchaser prior to arrival of the Supplier at site shall be debited to the Supplier and all such goods shall be handed over to the Supplier when it reports at site and thereupon the Supplier shall inspect the same and furnish a receipt to the Purchaser. The manner in which the inspection shall be carried out is enumerated below:

11.3.1 The materials/equipment would be carefully unpacked by opening the wooden cases/other modes of packings as the case may be.

11.3.2 Detailed inventory of various items would be prepared clearly listing out the shortages, breakages/damages after checking the contents with respect to the supplier's packing list, the Purchaser's Contract and approved equipment drawings. The Supplier shall also check every equipment for any shortage/shortcoming that may eventually create difficulty at the time of installation or commissioning.

11.3.3 All the information and observations by the Supplier shall be furnished in the form of 'INSPECTION REPORT' to the Purchaser with specific mention/suggestions which in the opinion of the Supplier should be given due consideration and immediate necessary actions, to enable the Purchaser to arrange repair or replacement well in time and avoid delays due to non-availability of equipment and parts at the time of their actual need.

11.3.4 The inspection for all the Goods handed over to the Supplier shall be completed within three weeks' period.

11.4 The protection, safety and security of the Goods so taken over from the Purchaser shall be the responsibility of the Supplier, until they are handed over to the Purchaser after erection, commissioning and testing as per the terms of the Contract.

12.0 STORAGE OF GOODS

The Supplier shall be responsible for the proper storage and maintenance of all Goods under Supplier's custody. Supplier shall take all required steps to carry out frequent inspection of equipment/materials stored as well as erected equipment until the same are taken over by the Purchaser. The following procedure shall apply for the same.

12.1 The Supplier’s inspector shall check stored and installed Goods to observe signs of corrosion, damage to protective coating to parts, open ends in pipes, vessels and equipment, insulation resistance of electrical equipment etc. The Supplier shall immediately arrange a coat
of protective painting whenever required. A record of all observations made on Goods, defects noticed shall be promptly communicated to the Purchaser and Purchaser’s advice taken regarding the repairs/rectifications. The Supplier shall thereupon carry out such repairs/rectifications at Supplier’s own cost. In case the Supplier is not competent to carry out such repairs/rectifications, the Purchaser reserves the right to have this done by other competent agencies at the Supplier’s responsibility and risk and the entire cost for the same shall be recovered from the Supplier’s bills.

12.2 The Supplier’s inspector shall also inspect and provide lubrication to the assembled Goods. The shafts of such equipment shall be periodically rotated to prevent rusting as well as to check freeness of the same.

12.3 The Inspector shall check for any signs of moisture or rusting in any Goods.

12.4 If the commissioning of Goods is delayed after installation of the Goods, the Supplier shall carry out all protective measures suggested by the Purchaser during such period.

12.5 Adequate security measures shall be taken by the Supplier to prevent theft and loss of Goods handed over to the Supplier by the Purchaser. The Supplier shall carry out periodical inventory checks of the Goods received, stored and installed by the Supplier and any loss noticed shall be immediately reported to the Purchaser. A proper record of these inventories shall be maintained by the Supplier. The Supplier should not sell, assign, mortgage, hypothecate or remove Goods which have been installed or which may be necessary for completion of the work without the written consent of the Purchaser.

12.6 A suitable grease recommended for protection of surfaces against rusting (refined from petroleum oil with lanclin minimum (70 deg C) and water in traces) shall be applied over all Goods as required once in every six months.

12.7 All Goods shall be stored inside a closed shed or in the open depending upon whether they are of indoor or outdoor design. The space heaters where provided into the electrical equipment shall be kept connected with power supply irrespective of their type of storage. Where space heaters are not provided adequate heating with bulb is recommended. For transformers heating of oil shall be done by giving 440 V supply and short-circuiting the LT terminals. Frequent checks on insulation resistance are essential for all electrical equipment and record of the inspection reports and megger readings shall be maintained equipment wise. Such records shall be presented to the Purchaser whenever demanded.

12.8 All the necessary Goods required for protection as described above shall be arranged by the Supplier and such cost shall be included in the Contract Price.

Should the amount of extra or additional work of any kind or any cause of delay referred to in these conditions, or exceptional or adverse climatic conditions, or other special circumstances of any kind whatsoever which may occur, as described in Clause 25 of the General Conditions of Contract, other than through a default of the Supplier, be such as fairly to entitle the Supplier to an extension of time for the completion of the works, the Purchaser shall determine the amount of such extension and shall notify the Supplier accordingly. Provided that the Purchaser is not bound to take into account any extra or additional work or other special circumstances unless the Supplier has within twenty-eight days after such work has been commenced, or such circumstances have arisen, or as soon thereafter as is practicable, submitted to the Purchaser full and detailed particulars of any extension of time to which he may consider himself entitled in order that such submission may be investigated at the time.

13.0 APPROVALS

13.1 The Supplier shall obtain the necessary approvals of the Factory Inspector, Boiler Inspector, Electrical Inspector, Weights & Measures Inspector, Explosive Inspector and any other state and local authorities as may be required and the cost of obtaining such approvals shall be included
in the Contract Price. All the necessary details, drawings, submission of application and proformas will be furnished by the Supplier to the Purchaser for verification/signature. The necessary application duly filled-in, together with the prescribed fees shall be submitted to the appropriate authorities by the Supplier on behalf of the Purchaser. However all the actual statutory prescribed fees paid by the Supplier shall be reimbursed by the Purchaser upon production of the receipt/vouchers.

13.2 Wherever necessary or required, the Supplier shall furnish the necessary test and/or inspection certificates etc. from the appropriate authorities as per IER and other statutory regulations and the cost for obtaining these certificates shall be included in the Contract Price.

14.0 REVIEW AND CO-ORDINATION OF ERECTION WORK

The Supplier shall depute senior and competent personnel to attend the site co-ordination meetings that would generally be held at the site every month. The Supplier shall take necessary action to implement the decisions arrived at such meetings and shall also update the erection schedule.

15.0 EXTENSION OF TIME FOR COMPLETION

Should the amount of extra or additional work of any kind or any cause of delay referred to in these conditions, or exceptional or adverse climatic conditions, or other special circumstances of any kind whatsoever which may occur, as described in Clause 24 of the General Conditions of Contract, other than through a default of the Supplier, be such as fairly to entitle the Supplier to an extension of time for the completion of the works, the Purchaser shall determine the amount of such extension and shall notify the Supplier accordingly. Provided that the Purchaser is not bound to take into account any extra or additional work or other special circumstances unless the Supplier has within twenty-eight days after such work has been commenced, or such circumstances have arisen, or as soon thereafter as is practicable, submitted to the Purchaser full and detailed particulars of any extension of time to which he may consider himself entitled in order that such submission may be investigated at the time.
## SPECIAL CONDITIONS OF CONTRACT FOR INSTALLATION

### PART – III - A

**MECHANICAL INSTALLATION**

**TABLE OF CLAUSES**

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<td>General Installation</td>
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<tr>
<td>Service Piping Installation</td>
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<tr>
<td>Special Instructions and specifications</td>
</tr>
<tr>
<td>Insulation of Piping and Equipment</td>
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<td>Interconnections of Service and Electricals with equipment</td>
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<td>Clean up of Works Site</td>
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<td>Cleaning chemicals and lubricants</td>
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<tr>
<td>Testing, commissioning and start-up</td>
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<td>Painting</td>
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<td>General specifications for pipes and fittings</td>
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<td>Annexure-1 Format of makes for bought out items</td>
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SPECIAL CONDITIONS OF CONTRACT

PART III - A

(MECHANICAL INSTALLATION)

1.0 MECHANICAL INSTALLATION

The installation work would comprise:

a. General installation i.e. positioning and installing all the processing, miscellaneous and service equipment as per approved layout drawings and as per the contract.

b. Supply and installation of structural platforms and tables.

c. Supply and installation of all service and product piping including ancillary items.

d. Insulation and cladding of piping and equipment including supply of materials.

e. Interconnections of services and electrical with equipment.

f. Guide line for expansion work.

g. Clean up of work site.

h. Supply of all cleaning chemicals and lubricants.

i. Testing, commissioning and start-up.

j. Painting including supply of paints as approved by the Owner.

k. Training of personnel.

Detailed specifications are given in the subsequent clauses.

2.0 GENERAL INSTALLATION

2.1 Positioning of Equipment

The work involves preparation of access for moving of the plant and equipment including their fittings from the work site godown or from the place within the site where they have been unloaded, to the place of erection, decorating and placing on the foundation wherever required. All the civil foundations as per the manufacturer/supplier’s drawings shall be arranged by the Supplier. The Supplier shall place the equipment and carry out final adjustment of the foundations including alignment and dressing of foundation surface, embedding and grouting of anchor bolts and bedplates. The Supplier shall be responsible for obtaining correct reference lines for purpose of fixing the alignment of various equipment from master benchmarks provided by the Owner.

Tolerances shall be as specified in equipment manufacturers drawings or as stipulated by the Owner’s Engineer. No equipment shall be permanently bolted down to foundations or structure until the alignment has been checked by the Supplier and witnessed by the Purchaser. The Supplier shall carry out minor alterations in the anchor bolts, pockets etc., at no extra cost and set the equipment properly as per approved layout drawings and manufacturer’s instructions. The Supplier shall supply all the necessary foundation/anchor bolts and bedplates if required without extra cost.

The Supplier shall supply, fix and maintain, at his own cost, during the erection work, all the necessary centering, scaffolding, staging required not only for proper execution and
The protection of the said work but also for protection of the surrounding plant and equipment. The Supplier shall take out and remove any or all such centering, scaffolding, staging planking etc., as occasion shall require or when ordered to do so and shall fully reinstate and make good all things disturbed during execution of the work, to the satisfaction of the Owner. The Supplier shall be paid no additional amount for the above.

2.2 Structural Platforms, Service Pipe Bridge and Tables

Box type structural platforms shall be required to provide access for various equipments. Pipe support bridges/gantry shall be required for supporting the pipes from the ground, including road crossings outside the buildings. These platforms, bridges / gantry shall be fabricated keeping stability and other functional as well as aesthetic requirements into consideration as approved by the Owner. The payment shall be made on the basis of the actual weight executed and the unit rates agreed upon or as per provisions made in the contract for such items.

The Purchaser shall arrange for any civil works required for the above works based on the drawings and load details provided by the bidder. Necessary templates and other accessories required by the civil contractor shall be provided by the bidder.

3.0 SERVICE PIPING INSTALLATION

3.1 General Guidelines

All piping systems shall comply with the latest editions of the following regulations wherever applicable.

3.1.1 Regulations of explosives inspectorate.

3.1.2 Indian Boiler Regulations

3.1.3 All applicable Indian Standards.

3.1.4 All applicable State Government/ Central Government laws /acts.

3.1.5 The Supplier has to prepare all erection drawings of the proposed plant including equipment positions and service-piping positions (Isometric), spacing between pipes, all other relevant details and submit these drawings to Purchaser for approval.

3.2 Scope of Supply

The Supplier shall supply all piping materials like pipes, fittings, flanges measuring instruments and all other items as shown in the flow diagram/specifications and schedule of quantities. All the pipes & fittings and insulation material etc. should be of class and make as approved by the Owner. Prior approval of the Owner must be obtained by the supplier for the class and make of all materials. The Supplier should furnish the details of makes selected by him, in the proforma given in Annexure I.

3.3 Scope of Piping Erection

This to be performed by the Supplier as outlined below:

3.3.1 The scope of erection for piping, includes all system covered in the flow diagrams and specifications.

3.3.2 The Supplier’s work commences / terminates at the pipe connections with valves or flanges as specified in flow diagrams / battery limits.

3.3.3 The Supplier shall also install necessary piping and any specialties furnished with or for equipment such as relief valves, built-in-pass and other items of this type.
3.3.4 The Supplier shall install primary elements for flow measurements, control valves and on-line metering equipment.

3.3.5 The Supplier shall perform necessary internal machining of pipes for installing orifices, flow nozzles, control valves etc.

3.3.6 The Supplier shall install all pipes, valves and specialties being procured from other sources.

3.4 Testing of Piping

3.4.1 The Supplier shall test all piping systems mentioned below including valves and specialties and instruments as per procedure mentioned under 3.4.4.

   a) H.P. & L.P. Steam piping
   b) Furnace oil & diesel piping
   c) Soft and raw water
   d) Compressed Air Piping

3.4.2 All piping shall be internally cleaned and flushed by the Supplier after erection in a manner suited to the service and as directed by the Owner.

3.4.3 For hydrostatic testing and water flushing, the Supplier shall furnish necessary pumps, equipment, instruments and piping etc.

3.4.4 The details of testing pressures for various pipelines are mentioned below:

<table>
<thead>
<tr>
<th>Sl. N</th>
<th>Name</th>
<th>Test Pressure Kg/cm²</th>
<th>Test Medium</th>
<th>Duration of Test (Hour)</th>
<th>Allowable Pressure Drop (Kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Steam Pipelines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 a</td>
<td>H.P. Steam</td>
<td>27</td>
<td>Water</td>
<td>½</td>
<td>0</td>
</tr>
<tr>
<td>1 b</td>
<td>L.P. Steam</td>
<td>8</td>
<td>Water</td>
<td>½</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Water Pipelines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 a</td>
<td>Raw Water, Soft Water</td>
<td>8</td>
<td>Water</td>
<td>½</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Furnace Oil/LSHS Pipelines</td>
<td>16</td>
<td>Water</td>
<td>½</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Air Pipelines</td>
<td>12</td>
<td>Air</td>
<td>½</td>
<td>0.1</td>
</tr>
</tbody>
</table>

3.5 Other Guidelines

3.5.1 Colour code shall be used to identify pipe material. The Supplier shall be able to identify on request all random piping prior to field fabrication.

3.5.2 The Supplier shall be responsible for the quality of welding done by them and shall conduct tests to determine the suitability of the welding procedure by him.

3.5.3 All piping supports, guides, anchors, hangers, rollers with structural framework shall be supplied and erected by the Supplier. Only anchor fasteners of adequate size shall be provided for anchoring supports from RCC structures and Hilti Gun shall be used for fastening the anchors. The kinds of pipe supports like CI clamps, PUF/wooden saddles, roller supports and support framework shall be as per the design approved by the Owner prior to taking up the work.
3.5.4 All piping shall be suspended, guided and anchored with due regard to general requirements and to avoid interference with other pipes, hangers, electrical conduits and their supports, structural members and equipment and to accommodate insulation and conform to buildings structural limitations. It is the responsibility to the piping Supplier to avoid all interference while locating hangers and supports.

3.5.5 Anchors and/or guides for pipelines or for other purposes shall be furnished, when specified, for holding the pipeline in position for alignment. Hangers shall be designed fabricated and assembled in such a manner that they cannot become disengaged by any movement of the support pipes.

3.5.6 All piping shall be wire brushed and purged with air blast to remove all rust, mill scale from inner surface. The method of cleaning shall be such that no material is left on the inner or on outer surfaces, which will affect the serviceability of the pipes. A thin coat of any lubricating oil shall be applied on entire inner surface of steel pipes (black) to prevent rusting.

3.5.7 Effective precautions such as capping and sealing shall be taken to protect all pipe ends against ingress of dirt and damage during transit or storage.

The outside of the steel pipes (black) shall be painted with two coats of red oxide paint or as directed by the Owner.

3.5.8 All pipes in the corridor shall be supported from the sidewall.

3.5.9 MS box section pipe supports for services / process equipment shall be provided by the supplier. Box section pipe supports for services and cable trays in other areas shall be of steel of suitable thickness coated with rust preventive paints and finish coated with dark admiral grey of approved shade. Where pipes and clamps are of dissimilar material, gaskets shall be provided in between. Spacing of utilities pipe supports shall not exceed the following:

<table>
<thead>
<tr>
<th>Pipe size</th>
<th>Spacing between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 12mm</td>
<td>1.5m</td>
</tr>
<tr>
<td>15 to 25mm</td>
<td>2.0m</td>
</tr>
<tr>
<td>30 to 150mm</td>
<td>2.0m</td>
</tr>
<tr>
<td>Over 150mm</td>
<td>2.5m</td>
</tr>
</tbody>
</table>

3.5.10 Vertical risers shall be parallel to walls and column lines and shall be straight and in plumb.

Risers passing from floor to floor shall be supported at each floor slab by clamps or collars attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at a lower point and air vent at the highest point.

3.5.11 Pipe sleeves at least 3 mm thick, 50 mm / 100 mm larger in diameter than the pipes shall be provided wherever pipe passes through walls and slabs. Annular space shall be filled with fibre glass and finished with retainer rings. No extra payment shall be made on account of providing the sleeves.

3.5.12 All piping works shall be carried out in a workman like manner, causing minimum disturbance to the services, buildings, roads and structures. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe support, pipes and pressure testing for each area shall be carried out in one stretch.

3.5.13 Cutouts details in the floors and slabs for installing various pipes are to be provided by the contractor immediately after receipt of the purchase order, so as to make the cutouts ready by civil contractor.
3.5.14 The contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints wherever required.

3.5.15 All pipes shall be accurately cut to the required size in accordance with the relevant BIS code and burrs removed before lying. Open ends of the piping shall be closed as the pipe is installed to avoid ingress of foreign matters. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for piping to drain fully. In other locations concentric reducers may be used.

3.5.16 All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with three layers of fibre glass tissue, each layer laid in bitumen.

3.5.17 Tee-off connections shall be through equal or reducing tees. Otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

4.0 SPECIAL INSTRUCTIONS AND SPECIFICATIONS

4.1 Steam Piping

4.1.1 Steam piping work can be classified into two categories:

a) High-pressure steam piping when the working pressure of steam is more than 3.1 kg/sq.cm (50 psi).
b) Low-pressure steam piping when the working pressure of steam is below 3.1 kg/sq.cm (50 psi).

All the pipes and fittings used for high pressure steam piping work should conform to IBR and they should be IBR certified and also to be identified with number and mark showing that they are tested by the Boiler Inspector and supported with duly authentic certificates to this effect. ALL HIGH PRESSURE STEAM PIPES SHALL BE SEAMLESS TYPE, SCHEDULE 40.

4.1.2 The high pressure steam piping after installation should be hydraulically tested in presence of the Boiler Inspector for his approval.

4.1.3 The high-pressure steam piping work should also include fabrication and installation of pressure reducing stations strictly conforming to IBR.

4.2 Water Piping:

All the piping for water, soft & raw water, steam & condensate, furnace oil, and air shall be generally of welded construction. Whenever welding is done for pipes of smaller size special care should be exercised to avoid clogging of flow area with the welding material.

5.0 INSULATION OF PIPING AND EQUIPMENT

5.1 Insulation of Steam, condensate and Hot Water Pipe Lines

All the steam and hot water pipelines shall be insulated with mineral wool or equivalent resin bonded pipe section of specified thickness. The insulation shall be carried out in the following manner and should be supplied in the form of properly required sizes.

5.1.1 Clean the surfaces to be insulated. Apply a coat of red oxide primer and fix glass wool / mineral wool / resin bonded pipe section of specified thickness, tightly to the pipes, butting all joints and tie with lacing wire.

5.1.2 It should then be covered with Gi wire netting of 20 mm x 24 SWG.

5.1.3 In case the insulation does not have the desired insulation properties, the entire insulation will have to be redone at the Supplier’s cost to give the desired results.
5.1.4 In case of condensate return piping all the steps mentioned above shall be executed except that thickness of the insulation shall be 25 mm.

5.2 Aluminum / GI Cladding

5.2.1 The ammonia accumulators, chilled water, ammonia, water, steam & hot water lines after insulations shall be covered by Aluminum / GI cladding as per the requirement and the payment will be made as per the executed items.

5.2.2 Aluminum cladding will be done with 22-gauge aluminum sheet with proper grooves and overlaps and screwed in position with 12 mm. self-tapping Parker screws.

5.2.3 GI sheet cladding will be done with 22 gauge sheet with proper grooves and overlaps and screwed in position with 12 mm self tapping parker screw. The GI sheet cladding will finally painted with 2 coats of approved shade and quality of paint.

5.2.4 All the necessary materials of quantity and make approved by the Owner, required for carrying out insulation, cladding and other works mentioned above, shall be supplied by the Supplier.

6.0 INTER CONNECTIONS OF SERVICE AND ELECTRICALS WITH EQUIPMENT

6.1 The Supplier shall lay service piping and provide connections with the equipment complying strictly with the equipment manufacturers' instructions. The Supplier shall also carry out all the interconnecting service piping with the various items of plant/system. The work shall be complete with capillary piping if required and connections with instruments and controls supplied with the equipment.

6.2 The Supplier shall also carry out electrical connections for equipment with the control panels including equipment lighting as per the wiring diagrams of the equipment suppliers.

Connection shall be made for small electrically operated devices on equipment installed as accessories to, or assembled with equipment. Connections regarding instruments, float switches, limit switches, pressure switches, thermostats and other miscellaneous equipment shall be done as per manufacturers' drawings & instructions.

7.0 CLEAN UP OF WORKS SITE

7.1 All soils, filth or other matters of an offensive nature taken out of any trench, drain or other places shall not be deposited on the surfaces, but shall at once be carted away by the Supplier from the site of work for proper disposal.

7.2 The Supplier shall not store or place the equipment, materials or erection tools on the drive ways and passages and shall take care that his work in no way restricts or impedes traffic or passage of men and materials during erection. The Supplier shall without any additional payment, at all time keep the working and storage area used by him free from accumulation of dust or combustible materials, waste materials rubbish packing, wooden planks to avoid fire hazards and hindrance to other works.

7.3 If the Supplier fails to comply with these requirements in spite of written instructions from the Owner, the Owner will proceed to clear these areas and the expenses incurred by the Owner in this regard shall be payable by the Supplier. Before completion of the work, the Supplier shall remove or dispose off in a satisfactory manner all scaffolding, temporary structures, waste and debris and leave the premises in a condition satisfactory to the Owner. Any packing materials received with the equipment shall remain as the property of the owner and may be used by the Supplier on payment of standard charges to the Owner and with prior approval of the Owner. At the completion of his work and before final payment, the Supplier shall remove and shall restore the site to neat workman like conditions at his cost.
8.0 CLEANING CHEMICALS AND LUBRICANTS

The necessary quantities of cleaning chemicals and the first charge of oil and lubricants required for the installation, commissioning, testing and start-up of all the equipment till handing over are to be supplied by the Supplier and nothing extra would be paid for these.

9.0 TESTING, COMMISSIONING AND START-UP

9.1 The Supplier shall operate, maintain and give satisfactory trial run of the plant in such manner and for such periods as has been specified in Section IV (Technical Specifications). All rectification of damages / defects during the trial period should be carried out by the Supplier.

9.2 The commissioning shall also include the following for each equipment:

9.2.1 Field disassembly and assembly of equipment, instruments and controls where required for access to fixing or adjustment.

9.2.2 Clean out of lubrication system including chemical cleaning wherever required.

9.2.3 Circulation of lubricant to check flow.

9.2.4 Clean out and check out of all the service lines.

9.2.5 Check out and commissioning of instruments, equipment and plants, filtering of transformer and other oils so that if deteriorated, they shall attain the required properties / standards, specified tests in this regard must be carried out by approved authorities and their satisfactory reports submitted to the Owner before start-up.

9.2.6 Recharging or make-up filling of lubricant oil up to the desired level in the lubrication system of individual machine.

9.2.7 Operation in empty condition to check general operation details wherever required and wherever possible.

9.2.8 Closed loop dynamic testing with water wherever required.

9.2.9 Operation under load and gradual load increase to attain maximum rated output.

9.2.10 Trouble shooting during the trial period.

9.3 The Supplier shall demonstrate proper working of all mechanical and electrical controls; safety and protective device, in presence of the Owner’s engineer and the same should be duly recorded.

Commissioning of automation system:

The supplier should provide a detailed schedule of testing all automation and control systems.

All controlled or monitoring devices on the plant should be tested from the relevant control centre and recorded to be operating as designed, including feedback detection.

A log of these operations is to be maintained, and each completed group of tests to be signed by the supplier’s commissioning engineer.

The Purchaser reserves the right to witness as much of these test procedures, as he may feel necessary.

Testing procedures and commissioning period will be as specified in Section IV.
9.4 After conducting testing, in case, a particular equipment is not working properly or not giving rated output the Supplier will furnish a detailed report to the Owner stating therein the detailed account on the performance of the equipment with possible reasons for improper or not working of the same and will arrange the visit of the representative of original manufacturers to get the same commissioned satisfactorily.

9.5 After satisfactory commissioning and start-up, the Supplier shall keep/depute his representatives at the plant in the manner, for the duration and for the performance of such tasks as specified in Section III. During this period the Supplier shall ensure proper working of complete plant and equipment and attend any works required to be done for proper operation of the complete plant and equipment.

10.0 PAINTING

All the equipment / machineries like motors, pumps, HT / LT panel, transformer, switch boards, starters, junction boxes, isolators, storage tanks, supporting structures, pipe supports and MS/Gi pipes and all exposed and visible iron parts included in the scope of erection / commissioning shall be given double coat of paint of approved shade over a double coat of anti-corrosive primer wherever necessary irrespective of the condition of original paint of equipment/machineries/structures/supports. All surfaces, wherever required, must be properly cleaned from scale, dirt and grease prior to painting. Spray painting must preferably be used on all the equipment /machineries and wherever practicable. Suitable and necessary cleaning / wiping of sight / dial glasses, other non-metallic parts, flooring, walls and other surfaces which have been spoiled by paint during painting must also be carried out by the Supplier.

Lettering and other markings, including capacity and flow direction markings, shall also be carried out by the Supplier on the tanks, pipe lines, starters and wherever else necessary, as directed and as per the standard practice of installation. BIS colour codes and colour charts as mentioned in Annexure - II must be adhered to.

Supply of all paints and all other materials required for painting is included in the scope of supply of the Supplier under this contract/order.

11.0 TRAINING OF PERSONNEL

Necessary staff as may be deputed by the Owner shall be trained by the Supplier for operating the plant. The personnel will be associated for the training during the installation; testing, commissioning and start-up period and the training tenure shall be extended for a minimum period of one month from the date of commissioning and start-up. This training will be a continuous process during commissioning and stand by period and as described in the Technical Specifications.

- GENERAL SPECIFICATIONS FOR PIPES AND FITTINGS

- Flanges shall be of good make. The supply of flanges shall also include supply of bolts, nuts, washers and suitable asbestos fibre /rubber insertion food grade gaskets (minimum 3mm thick).

- The above specifications for valves are general specifications. However, pipes and valves shall be required to be supplied as per details mentioned in Section III - the technical specifications of plant and equipment.

- LIST OF APPROVED MAKES FOR MAJOR COMPONENTS

A table of makes of various major components is given under Technical Specifications Section III. The supplier will adhere to makes of items as per this list only. For an item not mentioned in the table or item having more than one preferred / approved make, supplier will obtain approval of the Purchaser for the make before initiating actual procurement.
<table>
<thead>
<tr>
<th>Piping Service</th>
<th>Material</th>
<th>Specification</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP Steam (IBR Approved)</td>
<td>Heavy duty, seamless Cast Steel</td>
<td>Schedule 40, ASTM A 53</td>
<td>Piping to be welded type</td>
</tr>
<tr>
<td>LP Steam</td>
<td>ERW, Heavy duty (C-class)</td>
<td>BIS: 1239, 3601</td>
<td>Piping to be welded type</td>
</tr>
<tr>
<td>Air</td>
<td>ERW, Heavy duty (C-class)</td>
<td>BIS: 1239, 3601</td>
<td>Piping to be welded type</td>
</tr>
<tr>
<td>Water Supply, bleeds, drains, etc.</td>
<td>Galvanised steel (ERW) medium duty class B</td>
<td>BIS:1239/BIS:3589</td>
<td>Piping to be welded type</td>
</tr>
<tr>
<td>SS Duct</td>
<td>TIG welded, annealed and decaled, outside mirror polished &amp; inside pickled as per dairy standards</td>
<td>AISI 304</td>
<td>Welded corci;ar During with Flanged joints</td>
</tr>
<tr>
<td>MANUALLY OPERATED VALVES:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hp Steam (IBR Approved)</td>
<td>Cast steel body Globe / Piston Valve &amp; NRY with SS working parts</td>
<td></td>
<td>Flanged &gt; 25 Screwed&lt; 25 NB</td>
</tr>
<tr>
<td>LP Steam</td>
<td>Cast steel/GM body Globe/ Piston Valve &amp; NRV with SS working parts</td>
<td></td>
<td>Flanged &gt; 25 NB Screwed&lt; 25 NB</td>
</tr>
<tr>
<td>Air</td>
<td>Cast steel / GM body Globe/ Piston Valve &amp; NRV with SS working parts rubber (Inert to moisture &amp; oil traces)</td>
<td></td>
<td>Flanged&gt; 25 NB Screwed&lt;25 NB</td>
</tr>
<tr>
<td>Soft / Raw water: Over 75 mm Upto 75 mm</td>
<td>Cl, butterfly Cs ball valve</td>
<td>IS: 778, 1703</td>
<td>Flanged&gt; 25 NB Weldable up to 25 NB</td>
</tr>
<tr>
<td>Water supply, bleeds, And drain</td>
<td>Cast steel ball valve</td>
<td>IS:778</td>
<td>Flanged&gt; 25 NB</td>
</tr>
</tbody>
</table>
 FORMAT OF MAKES OF BOUGHT OUT ITEMS SELECTED BY SUPPLIER:

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Name of the item</th>
<th>Make Selected by Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Preference</td>
</tr>
<tr>
<td>1</td>
<td>Steam Piping</td>
<td></td>
</tr>
<tr>
<td>1 a</td>
<td>MS C class pipes (Seamless)</td>
<td></td>
</tr>
<tr>
<td>1 b</td>
<td>Cast Steel globe valves</td>
<td></td>
</tr>
<tr>
<td>1 c</td>
<td>Bronze globe valves</td>
<td></td>
</tr>
<tr>
<td>1 d</td>
<td>Cast Steel Non- return valves</td>
<td></td>
</tr>
<tr>
<td>1 e</td>
<td>Gun metal Non- return valves</td>
<td></td>
</tr>
<tr>
<td>1 f</td>
<td>Pressure reducing valves, safety valves, strainer, moisture separator, steam trap, expansion joints &amp; other steam fittings.</td>
<td></td>
</tr>
<tr>
<td>1 g</td>
<td>Pressure &amp; temp. gauges</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Furnace oil piping/air piping</td>
<td></td>
</tr>
<tr>
<td>2 a</td>
<td>MS C class pipes (Seamless)</td>
<td></td>
</tr>
<tr>
<td>2 b</td>
<td>Cast Steel globe/ Bronze globe valves/ Gun metal gate valves</td>
<td></td>
</tr>
<tr>
<td>2 c</td>
<td>Gun metal NRV</td>
<td></td>
</tr>
<tr>
<td>2 d</td>
<td>Pressure gauges</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Water piping</td>
<td></td>
</tr>
<tr>
<td>3 a</td>
<td>GI 'B' Class Pipe</td>
<td></td>
</tr>
<tr>
<td>3 b</td>
<td>CI globe valve</td>
<td></td>
</tr>
<tr>
<td>3 c</td>
<td>Gun metal gate valve</td>
<td></td>
</tr>
<tr>
<td>3 d</td>
<td>Gun metal globe valves/ strainers / non- return valves</td>
<td></td>
</tr>
<tr>
<td>3 e</td>
<td>Water Pump</td>
<td></td>
</tr>
<tr>
<td>3 f</td>
<td>Foot valve</td>
<td></td>
</tr>
<tr>
<td>3 g</td>
<td>Water meter</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Insulation materials</td>
<td></td>
</tr>
<tr>
<td>4 a</td>
<td>Expanded polystyrene</td>
<td></td>
</tr>
<tr>
<td>4 b</td>
<td>Glass/ mineral wool</td>
<td></td>
</tr>
<tr>
<td>4 c</td>
<td>Resin bonded mineral wool</td>
<td></td>
</tr>
<tr>
<td>4 d</td>
<td>Polyurethane foam</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Cables</td>
<td></td>
</tr>
<tr>
<td>5 a</td>
<td>Powder Cables</td>
<td></td>
</tr>
<tr>
<td>5 b</td>
<td>Control Cables</td>
<td></td>
</tr>
<tr>
<td>5 c</td>
<td>Instrumentation &amp; Signal cables</td>
<td></td>
</tr>
</tbody>
</table>

Important note:

The make of all bought out items / components should be got approved at one instance only and the makes thus approved shall only be supplied.
CODE OF PRACTICE FOR PAINTING OF SERVICE PIPE LINES, EQUIPMENT AND STRUCTURAL WORK

1.0 PAINTING OF SERVICE PIPE LINES

1.1 On Non-insulated Pipe Line

1.1.1 Ground colour to be applied throughout the length of the pipeline.

1.1.2 Colour bands to be applied, over the ground colour, near every valve and branch connections as well as in every room near the entry.

1.1.3 The relative proportional widths of the 1st colour band to the subsequent bands shall be 4:1. The minimum width of colour band shall confirm to the following table:

<table>
<thead>
<tr>
<th>Nominal Pipes Size</th>
<th>Width of 1st Colour band</th>
<th>Width of 2nd Colour band</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 NB and below</td>
<td>100 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>100 NB to 150 NB</td>
<td>200 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>200 NB to 300 NB</td>
<td>300 mm</td>
<td>75 mm</td>
</tr>
<tr>
<td>350 NB and above</td>
<td>400 mm</td>
<td>100 mm</td>
</tr>
</tbody>
</table>

1.1.4 On the 1st band a white arrow to be put to indicate the direction of flow.

1.1.5 The arrows should be put on the bottom of the pipelines so that the same are visible from below in case of horizontal bank of pipes and on sides in case of vertical bank of pipes.

1.1.6 The valves should be painted with the same colour as the ground colour of the pipeline.

1.2 On Insulated Pipeline but without Aluminum Cladding Procedure same as above.

1.3 On Insulated Pipeline with Aluminum Cladding

1.3.1 Ground colour to be applied in a minimum length of 1000 mm of the pipe all round near every valve and branch connections as well as in every room near the entry. The complete length of the pipeline should not be painted.

Colour bands should be applied in the middle of every ground colour strip. The relative proportional widths of the 1st colour band to the subsequent bands shall be 4:1. The minimum width of colour band shall confirm to the following table:

<table>
<thead>
<tr>
<th>Nominal Pipes Size</th>
<th>Width of 1st Colour band</th>
<th>Width of 2nd Colour band</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 NB and below</td>
<td>100 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>100 NB to 150 NB</td>
<td>200 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>200 NB to 300 NB</td>
<td>300 mm</td>
<td>75 mm</td>
</tr>
<tr>
<td>350 NB and above</td>
<td>400 mm</td>
<td>100 mm</td>
</tr>
</tbody>
</table>

For insulated pipes, nominal pipe size means the outside diameter of pipe with insulation.

1.3.3 On the 1st band a white arrow is to be put to indicate the direction of flow of the fluid.
1.3.4 The arrows should be put on the bottom of the pipelines, so that the same are visible from below in case of horizontal bank of pipes and on sides in case of vertical bank of pipes.

1.3.5 The valves should be painted with the same colour as the ground colour.

1.4 The ground colours and the colours of the 1st and 2nd colour bands have been indicated on the enclosed list for the pipe lines carrying various types of fluids and gases. The list also indicates the shade nos. of the colours to be used. In case the exact shade is not available, the nearest possible shade in the same colour may be selected.

1.5 Only synthetic enamel paint should be used for the painting and band markings on the pipelines and it should be ensured that the finish should be glossy.

1.6 Where no colour bands have been recommended, only the ground colour is to be applied as per the above procedure. If only one colour band is recommended the width of the same should be as per the first band and applied on the ground colour. In case of 2 nos. colour bands, the 1st band and second band of width as per above table should be applied on the ground colour.

1.7 To avoid mixing of colours, it is recommended to apply the bands only after the ground colour paint is dry and subsequently to apply the arrow only after the 1st band paint is dry.

2.0 PAINTING OF EQUIPMENT & STRUCTURAL WORK

2.1 M.S. platforms/pipe supports/ Pipe bridges and any other Structures Dark admiral grey

2.2 Feed water tank, Water softening plant. Dark admiral grey

2.3 Coal handling equipment Black

2.4 HWG chimney and Generator exhaust Aluminum paint

2.5 Air Compressors Original colour

2.6 Weigh scales Original colour

2.7 HT & LT panels Original colour

2.8 LT distribution switchboards Original colour

COLOUR CODE FOR PIPELINES AS PER IS 2379-1963

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Services</th>
<th>Application</th>
<th>Ground colour Shade No. &amp; Shade No. as per BSI</th>
<th>First Band Colour Shade No. as per BSI</th>
<th>Second Band Colour Shade No. as per BSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HWG Feed Water</td>
<td>HWG feed water piping</td>
<td>Sea Green 217</td>
<td>French 166 Blue</td>
<td>Signal 537 Red</td>
</tr>
<tr>
<td>2</td>
<td>Drinking Water</td>
<td>Water lines for water coolers</td>
<td>Sea Green 217</td>
<td>French 166 Blue</td>
<td>Light 557 Orange</td>
</tr>
<tr>
<td>3</td>
<td>Treated Water</td>
<td>Soft water lines</td>
<td>Sea Green 217</td>
<td>French 166 Blue</td>
<td>Canary 309 Yellow</td>
</tr>
<tr>
<td>4</td>
<td>Cold Water</td>
<td>Chilled Water supply &amp; return lines</td>
<td>Sea Green 217</td>
<td>French 166 Blue</td>
<td>Canary 309 Yellow</td>
</tr>
<tr>
<td>5</td>
<td>Untreated</td>
<td>Raw water lines</td>
<td>Sea White</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>Green 217</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------</td>
<td>----------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Boiler Feed Water</td>
<td>Sea Green 217</td>
<td>Gulf - Red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Condensate</td>
<td>Sea Green 217</td>
<td>Light 410 Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Compressed Air</td>
<td>Sky Blue 101</td>
<td>Light 410 Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Instrument air</td>
<td>Sky Blue 101</td>
<td>French 166 Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Soft Water Equipment</td>
<td>Sea Green 217</td>
<td>Light 410 Brown</td>
<td>Signal 537 Red</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Steam</td>
<td>Aluminum to IS 2339</td>
<td>French 166 Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Furnace Oil</td>
<td>Light 410 Brown</td>
<td>French 166 Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Diesel</td>
<td>Light 410 Brown</td>
<td>French 166 Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Light Diesel Oil</td>
<td>Light 410 Brown</td>
<td>Brilliant 221 Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Drainage</td>
<td>All drain lines from Equipment building &amp; OH water Tank</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SPECIAL CONDITIONS OF CONTRACT FOR INSTALLATION

**PART – III - B**

**ELECTRICAL INSTALLATION**

#### TABLE OF CLAUSES

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scope</td>
</tr>
<tr>
<td>2</td>
<td>Standards</td>
</tr>
<tr>
<td>3</td>
<td>Equipment and accessories - Specifications</td>
</tr>
<tr>
<td>4</td>
<td>Erection of Equipment</td>
</tr>
<tr>
<td>5</td>
<td>Installation of Cable Network</td>
</tr>
<tr>
<td>6</td>
<td>Earthing Network</td>
</tr>
<tr>
<td>7</td>
<td>Two/Four Pole Structure</td>
</tr>
<tr>
<td>8</td>
<td>Bureau of Indian standards for electrical</td>
</tr>
<tr>
<td>9</td>
<td>Recommended cable sizes for Industrial wiring</td>
</tr>
</tbody>
</table>
SPECIAL CONDITION OF CONTRACT

PART III – B

ELECTRICAL INSTALLATION

1.0 SCOPE

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical system like high tension switchyard with accessories and equipment, transformers, HT panel vacuum circuit breakers, LT panels and power control centres, motor control centers, distribution boards, capacitor banks & panels, power, control & instrumentation cables, remote push button stations, motors, earthing network, etc. Requirement of a particular project shall be as specified in schedule of quantities/approved drawings or as per the battery limits fixed in the contract.

2.0 STANDARDS

2.1 The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specification/codes of practice of the Bureau of Indian Standards, approved drawings and the instructions issued by the Engineer-in-charge or his authorized representative, from time to time. Some of the relevant Indian Standards are listed in Annexure- III.

2.2 In addition to the standards as mentioned in 2.1, all works shall also confirm to the requirements of the following:

a). Indian Electricity Act and Rules framed there under. b).

Fire Insurance Regulations.

c). Regulations laid down by the Chief Electrical Inspector of the State / State Electricity Board. d).

Regulations laid down by the Factory Inspector of the State.

e). Any other regulations laid down by the local authorities.

f). Installation & operating manuals of original manufacturers of equipment.

3.0 EQUIPMENT AND ACCESSORIES – SPECIFICATIONS

This defines specifications and requirements mainly for the equipment and accessories which are generally supplied by the erection agency and do not cover the specification of main electrical equipment such as Transformers, HT and LT panels, switch boards and motors etc., which may be supplied by the Owner.

All materials, fittings and appliances to be supplied by the Supplier shall be of best quality and shall conform to the specification given hereunder. The equipment shall be manufactured in accordance with current Bureau of Indian Standard Specifications wherever they exist or with the BS or NMA specifications, if no such BIS are available. In the absence of any specification, the materials shall be as approved by the Owner or his authorized representative.

All similar materials and removable parts shall be uniform and interchangeable with one another.

Makes of bought out items selected by the Supplier must be furnished by him.

3.1 Power Cables (HT)

Three core, Aluminium conductor, screened, XLPE insulated, armored shielded and PVC sheathed cables suitable for 11 / 22 / 33 KV, earthed system, conforming to IS 7098 (Part II) - 1988 amended upto date.
3.2 Power Cables (LT)

Power cables for use on 415 V system shall be of 1100 volt grade, aluminum conductor, XLPE insulated, PVC sheathed, armoured and overall PVC sheathed, strictly as per IS: 7098 (Part I) / 88. Conductor of cable shall be solid type for sizes upto 6 sq.mm and stranded for sizes above 6 sq.mm. Unarmoured cable to be used only if specifically mentioned in schedule of quantities.

The size of these cables shall be as specified in schedule of quantities or as per erection drawings. If neither of these are available, the size of cable shall be as specified in cable selection chart enclosed at Annexure-IV. NO CABLE OF SIZE LESS THAN 4 SQ. MM. WITH ALUMINUM CONDUCTOR OR 2.5 SQ. MM WITH COPPER CONDUCTOR SHALL BE USED.

3.3 Control Cables

3.3.1 Control cables for power

Control cables for use on 415 V. system shall be of 1100 volts grade, copper conductor, PVC insulated, PVC sheathed, armoured and overall PVC sheathed, strictly as per IS: 1554 (Part I) - 1976 amended up to date. Conductor of cable shall be solid type for sizes upto 2.5 sq mm and stranded for higher sizes. Unarmoured cables to be used only if specifically mentioned in schedule of quantities.

The size of these cables shall be as specified in schedule of quantities or as per erection drawing. The minimum size of conductor shall be 1.5 sq. mm.

3.3.2 Screened control cables for Analogue signals:

These shall be used for carrying out analogue signals. Multi-stranded base annealed copper conductor, PVC insulated, cores colour coded, laid up, screened by braiding with ATC copper wire and finally overall PVC sheathed. Sizes of their cable shall be as specified in schedule of quantities/approved drawings. These cables shall be with armouring unless specified otherwise in Schedule of qualities/approved drawings.

3.4 Cable Trays

Functional requirement: Cable trays are used (based on the site condition) for laying the power and control cables inside the plant from PCC to the MCC & MCC to all motors/sub panels and wherever required.

Fabrication: These shall be perforated type, heavy duty, return flange or inward bend shape, manufactured from mild steel conforming to IS-2062 and hot dip galvanized as per IS 2629/BS-729. Width of cable tray shall be as per the requirement. Height to be minimum 50 mm and thickness of plate to be 1.5 mm up to 300 mm cable tray width. For cable trays having width more than 300 mm, height to be 75mm and thickness of plate to be 2.0 mm. Cable trays to be supplied to site in standard lengths of 2.5 M. Necessary accessories of cable trays such as coupler side plates for joining cable trays, bends, riser, inside riser, tee etc. must also be factory fabricated. Plain cable tray covers 1.5 mm thick to be supplied if specially required. Sample of cable tray to be got approved from Purchaser before supply. Cable tray for automation network/instrument/signal cables shall be separate from power & control cables.

3.5 Cable Glands

These shall be provided at both ends of armoured/ unarmoured electrical cables. Cable glands to be manufactured as per performance requirements of BS-6121 & IP 65 as per IS 13947 (Part I) amended as on date, with BRASS material accurately machined and NICKEL finish. These shall be of heavy-duty single compression type for cable conductor sizes above 35 sq.mm and weatherproof double compression type for cable conductor sizes upto 35
sq.mm. Single compression cable glands to be complete with checknut, gland body, 3 nos. metal washers, and outer seal rubber ring and compression nut. Double compression glands to be complete with check-nut, gland body, neoprene inner ring, armour clamping cone, armour clamping ring, armour clamping nut, neoprene outer ring, skid washer & outer seal nut. Sample of cable gland to be got approved from the Site in charge before supply.

3.6 Cable Connectors

Cable connectors, lugs/sockets, shall be of copper/aluminum alloy, suitably tinned solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments, etc.). The current rating of the lugs shall be the same as that of the respective cable conductors. If the aluminum lug is terminated on a brass stud or copper bus bar then bimetallic washer shall be used.

3.7 Cable Route Markers

These shall be galvanized Cast Iron plate with marking (LT/HT) and of diameter 150 mm with 600 mm long 25x25 mm MS angle riveted/bolted with this plate. Sample to be got approved before use.

3.8 Cable Indicators

These shall be self-sticking type and of 2 mm thick lead Strap for overall cable. PVC identification numbers, Ferrule shall be used for each wire.

3.9 Pipes for Cables

For laying of cables under RCC floor, GI class 'A' pipes shall be used. For laying cable in air where cable trays are not being used, GI 'A' class pipe shall be used. Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. NO PIPE LESS THAN 40 MM DIA SHALL BE USED FOR THIS PURPOSE. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable. If length of pipe is more than 30 M, free area may be increased to 50%. All cable (power / control / instrument / signal) drops shall be in conduit pipe. The open ends of power/control cables at termination shall be protected through suitable conduit. Instrument/signal cable/wire drops upto termination point shall be also routed through conduits. The automation cables (plant/system/field bus, instrument/signal cables/wires shall be laid in cable trays through GI conduit.

3.10 Motor Isolators

These shall be in Aluminum cast housing, completely dust, vermin and weather proof (IP 65), suitable for 30/25 A, 415 volts, 50 Hz with rotary type switch complete with cable gland for incoming and outgoing cables. Final finish of housing to be buffer mirror or powder coated grey. Instead of AL cast housing, thermoplastic housing with IP 55 / 65 protection can also be used. From isolator to motor, adequately sized flexible copper wire in suitable heavy duty (wire ribbed) PVC flexible conduit to be used. Sample of isolator housing and conduit to be got approved before supply. Isolators shall be used for all on line started motors receiving single cable.

3.11 Motor Junction Box/Control Junction Box

These shall be in Aluminum cast housing or unbreakable, self extinguishing thermoplastics of high quality, completely dust, vermin and weather proof (conforming to minimum IP 65 class of protection), suitable for 25A, 415 volts, 50 Hz, with heavy duty bakelite / equivalent connector, complete with cable/conduit gland. These junction boxes are required on all floors near equipment for final connection of multi core control cables/signal cables to various field devices. They may also be used for star delta started motors for final connection to motor, through adequately sized flexible copper wire in suitable heavy duty (wire ribbed) PVC flexible conduit. Sample to be got approved before supply.
3.12 Remote Push Button Stations

These shall be used for remote ON-OFF for motors, away from MCC. These shall be suitable for surface/structure mounting in Cast Aluminum housing having IP-65 class of protection i.e., completely weather proof. For each motor, one ON, one OFF red mushroom half turn to lock button, one LED type indication lamp to be provided with a heavy duty connector inside the housing to receive control cables. If more than one motor is nearby, a common ON-OFF station can be used of suitable size made from SS 304 2thk. Indication lamp can be combined with ‘ON’ (Green) push button in place of providing separate indication lamp and push button. Riveted type plastic nameplate to be provided for each feeder. If functionally required Ammeter also can be located in such ON-OFF station.

4.0 ERECTION OF EQUIPMENT

The cases containing the equipment (being supplied by the Purchaser) shall be handed over to the supplier. The Supplier shall make his own arrangements for safe transportation of all the items to the erection site and also carry out complete loading/unloading during transportation. Equipment shall not be removed from packing cases unless the floor has been made ready for installing them. The cases shall be opened in presence of the Engineer-in-charge or his authorized representative. These empty packing cases shall be returned to the stores and any document if found with the equipment shall be handed over to the Engineer-in-charge. Any damage or shortage noticed shall be reported to the Engineer-in-charge in writing immediately after opening of packing cases.

4.1 Transformer

4.1.1 Erection

Transformer complete with radiators, bushings, conservator and miscellaneous accessories shall be thoroughly inspected and any damage noticed shall be reported to the Engineer-in-charge. Before erection of transformer the level of rails on foundation shall be checked and minor corrections if necessary shall be carried out. After the completion of erection, necessary stoppers shall be provided at the wheels. All loosely supplied fittings/accessories shall be cleaned and mounted on the transformer and connections made. If the transformer oil is supplied in drums by the manufacturer, the same shall be tested for dielectric strength etc. and only approved oil "on test" shall be filled into the tank through filtration system. While filling in transformer with oil, samples shall be taken from the bottom and conservator and tested for dielectric strength. Fresh silica gel shall be filled in the breather. After complete assembling installation, filling and topping the transformer with oil, the transformer shall be cleaned and touch-up paint supplied by the manufacturer applied wherever necessary. All tank cover bolts shall be checked for proper tightness.

The foundation of transformer and rail fixing will be made by some other agency.

4.1.2 Testing

For testing of the dielectric strength of insulating oil in oil-immersed equipment, test samples of oil shall be drawn from equipment after filling. In case oil is supplied in separate containers for filling or topping up at the site, a test also shall be made with samples drawn from such oil container before the equipment is filled.

Minimum acceptable values for each test will be indicated by the Engineer-in-charge. However, dielectric strength of oil should be about 40 KV (RMS) for one minute.

By measuring the dielectric strength of the oil in the transformers, if tests indicate the presence of undue amount of moisture, the insulation oil shall be filtered by steam line filter. No extra charges shall be paid for filtration and the supplier shall arrange his own filtration machine, oil testing kit and other accessories.
Winding insulation resistance shall be measured from primary and secondary to ground and between primary and secondary.

Test the operation of Buchholz relay in accordance with the manufacturer's instructions.

Test the operation of the tap changer. Measure primary and secondary voltage ratios are as per nameplates.

Check the polarity of terminals and the phase's sequence.

4.1.3 Performa for Transformer Tests

1. Transformer nameplate
2. Insulation resistance test with 1000 V Megger
   a. between primary to earth .... Mega ohm
   b. Between secondary to earth .... Mega ohm
   c. Between primary and secondary .... Mega ohm
3. Dielectric strength of oil in the transformer (test Voltage 40 KV for one minute).
4. Operation of Buchholz relay as per manufacturers Instructions.
5. Operation of the tap changer
   Operation of the tap at     
   tap no.1
   tap no.2
   tap no.3
   tap no.4
   tap no.5
6. Polarity marking and phase sequence.
7. Condition of silicated crystals.
8. Earth resistance: Neutral / tank

(This proforma shall be jointly signed by the Engineer-in-charge and the supplier).

4.2 Power control centres, MCC, Distribution Boards, Control Panels & Bus Ducts

4.2.1 Erection

Electrical panels and bus duct shall be delivered in convenient shipping section by the manufacturers. The Supplier shall be responsible for final assembly and inter-connection of busbars/wiring. Foundation channel shall be grouted in the flooring by the Supplier. Switchgear Panels shall be aligned and leveled on their base channels and bolted or tack welded to them as per the instructions of the Engineer-in-charge. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. The contacts of the draw-out circuit breakers shall be checked for proper alignment and inter-changeability.

After erection the switchboard shall be inspected for dust and vermin proof. Any hole, which might allow dust or vermin etc. to enter the panel, shall be plugged suitably at no extra cost.

If the instrument transformers are supplied separately they shall be erected as per the direction of the Engineer-in-charge. The Supplier shall fix the cable glands after drilling the bottom / top plates of all switchboards with suitable holes at no extra cost.
Range of overload relays/timers etc. shall be checked with requirement of motor systems actually to be connected at site and if the same is under-sized/over-sized, it shall be brought to the notice of Engineer-in-charge, who shall arrange procurement of correct rated components. However, the supplier shall not charge anything extra for labour for such replacements.

The bus duct shall be suitably supported between Power Control Centre and transformer. The opening in the wall where the duct enters the switchgear room shall be sealed to avoid rainwater entry. The foundation of the Power Control Centre shall be raised suitably for minor adjustment to ensure proper alignment and connection of the bus duct at no extra cost. Expansion joints, flexible connection, etc. supplied by the manufacturer of the bus duct shall be properly connected.

4.2.2 Testing

Before electrical panel is energized, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contact open.

Before switchgear is energized, the insulation resistance of all DC control circuits shall be measured from line to ground.

Before switchgear is energized, the test covered above shall be repeated with each breaker in its normal operating position.

Capacitor banks in capacitor control panel shall be tested as per manufacturer’s instructions. In addition test for output and/or capacitance, insulation resistance test and test for efficiency of discharge device shall be carried out.

All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The Supplier shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets (if required) etc. shall also have to be arranged by the Supplier. Payment for above work shall be deemed to have been included in the erection of switch boards/control panels.

4.2.3 Proforma for PCC, DB, Motor Control Centers test

1. Circuit (breaker or Supplier module designation/ bus no.).
2. Insulation resistance test (contacts open, breaker racked in position).
   a. Between each phase of bus: Mega ohm
   b. Between each phase and earth: Mega ohm
   c. DC and AC control & auxiliary Circuits: Mega ohm
   d. Between each phase of CT/PT & between CT & PT circuit, if any: Mega ohm
3. CT checks:
   a. CT ratio
   b. CT secondary resistance
   c. CT polarity check
4. Check for contact alignment and wipe.
5. Check/test all releases/relays.
6. Check mechanical interlocks.
7. Check electrical interlocks.

8. Check switchgear/control panel wiring.

9. Checking breaker/Supplier circuits for
   a. Closing- local and remote (wherever applicable)
   b. Tripping-local and remote (wherever applicable)

10. Opening time of breaker/contactor.

11. Closing time of breaker/contactor.

(The Engineer-in-charge and the Supplier shall jointly sign this proforma.)

4.3 Sealed Maintenance Free Batteries & Battery Charger

Batteries shall be erected on powder coated MS stands and insulators supplied by the manufacturer of the batteries. Inter connectors shall be made with leads supplied by the manufacturer. Charging discharging and recharging shall be carried out under the supervision of the Engineer-in-charge or his authorized representative Erection of battery charger and DC board will be carried out by the Supplier under the supervision of the Engineer-in-charge or his authorized representative. The Supplier shall also offer such facilities as may be required for carrying out tests on the complete battery charger and DC board/AC board.

Battery charger shall be tested for proper operation and to verify the charger delivers its maximum rated output. The Supplier shall supply skilled/unskilled labour for carrying out the test by the engineer-in-charge.

Batteries shall be given a boost charge in accordance with the manufacturer's instructions and adjusted for float operation before being placed in regular service.

4.4 GEARED MOTORS AND GEAR BOXES:

These are required in feed plant for driving various slow speed machines. All slow speed machines to be run by geared motors only unless gear boxes have been specified in individual machines specification. The geared motor should use helical gears. The electric motor and helical gear box should be built as one unit. The geared motors / gear boxes should be suitable for minimum 15 start/stops per hour without undue heating, for continuous duty and minimum safety factor of 1.4.

The electric motors used for geared motors / gear boxes should be TEFC, degree of protection IP-55, squirrel cage, induction type, with class `F' insulation suitable for 415 V, 50 Hz, 3 phase AC supply.

Geared motors / boxes to be complete including key in the driven shaft, oil level indicator, oil filling plug, oil breather and drain plug. Suitable grade gear oil for first charge of geared motor / boxes should not be filled but should be packed separately in a drum and sent along with geared motor/boxes. Gear oil would be filled at site.

4.5 Electric Motors
All electric motors shall be energy efficient motors and shall comply with the following:

a) All poly phase motors of 0.375 kW or more shall have a minimum acceptable nominal full load motor efficiency not less than shown in Table below or as per the IS 12615 – 2004(Rev 1) for Eff1 energy efficient motors.
Table for Minimum Acceptable Motor Efficiencies

<table>
<thead>
<tr>
<th>Motor Size (KW)</th>
<th>2 Pole</th>
<th>4 Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.37 (0.5 hp)</td>
<td>70.2</td>
<td>69.4</td>
</tr>
<tr>
<td>0.55 (0.75 hp)</td>
<td>74</td>
<td>72</td>
</tr>
<tr>
<td>0.75 (1 hp)</td>
<td>78.5</td>
<td>74.6</td>
</tr>
<tr>
<td>1.1 (1.5 hp)</td>
<td>82.2</td>
<td>83.8</td>
</tr>
<tr>
<td>1.5 (2 hp)</td>
<td>84.1</td>
<td>85.0</td>
</tr>
<tr>
<td>2.2 (3 hp)</td>
<td>85.6</td>
<td>86.4</td>
</tr>
<tr>
<td>3.0 (4 hp)</td>
<td>86.7</td>
<td>87.4</td>
</tr>
<tr>
<td>4.0 (5.5 hp)</td>
<td>87.6</td>
<td>88.3</td>
</tr>
<tr>
<td>5.5 (7.5 hp)</td>
<td>88.6</td>
<td>89.2</td>
</tr>
<tr>
<td>7.5 (10 hp)</td>
<td>89.5</td>
<td>90.1</td>
</tr>
<tr>
<td>11.0 (15 hp)</td>
<td>90.6</td>
<td>91.0</td>
</tr>
<tr>
<td>15.0 (20 hp)</td>
<td>91.3</td>
<td>91.8</td>
</tr>
<tr>
<td>18.5 (25 hp)</td>
<td>91.8</td>
<td>92.2</td>
</tr>
<tr>
<td>22.0 (30 hp)</td>
<td>92.2</td>
<td>92.6</td>
</tr>
<tr>
<td>30.0 (40 hp)</td>
<td>92.9</td>
<td>93.2</td>
</tr>
<tr>
<td>37.0 (50 hp)</td>
<td>93.3</td>
<td>93.6</td>
</tr>
<tr>
<td>45.0 (60 hp)</td>
<td>93.7</td>
<td>93.9</td>
</tr>
<tr>
<td>50.0 (75 hp)</td>
<td>94.0</td>
<td>94.2</td>
</tr>
<tr>
<td>75.0 (100 hp)</td>
<td>94.6</td>
<td>94.7</td>
</tr>
<tr>
<td>90.0 (120 hp)</td>
<td>95.0</td>
<td>95.0</td>
</tr>
<tr>
<td>110.0 (150 hp)</td>
<td>95.0</td>
<td>95.0</td>
</tr>
<tr>
<td>132.0 (180 hp)</td>
<td>95.3</td>
<td>95.5</td>
</tr>
<tr>
<td>160.0 (215 hp)</td>
<td>95.5</td>
<td>95.8</td>
</tr>
<tr>
<td>180.0 (240 hp)</td>
<td>95.5</td>
<td>95.8</td>
</tr>
<tr>
<td>200.0</td>
<td>95.8</td>
<td>96.0</td>
</tr>
<tr>
<td>225.0</td>
<td></td>
<td>96.0</td>
</tr>
<tr>
<td>250.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) Motor nameplates shall list the nominal full-load motor efficiencies and the full-load power factor.
c) Certificates shall be obtained and kept on record indicating the motor efficiency.

4.5.1 Erection and testing

Erection and coupling of motors with machines will be done under the mechanical erection. However, earthing, cable termination, testing and commissioning are covered under this section. Before starting the alignment and coupling of motors with machines, the insulation resistance of the motors will be measured and recorded by the Supplier. Wipe, brush or blow accumulated dirt from the frame and air passages of the motor. Feel for air being discharged from the cooling air ports. If the flow is weak or unsteady then clean it. Dry the motor before installation if it has been lying in the store for a long time. Motors having low meager readings because of contamination by moisture, oil or conductive dust should be thoroughly cleaned and dried. The direction of the rotation of the motor shall also be checked before the driven equipment is finally coupled. Motor bearings are to be checked and rectified including supply and changing of grease (if required), checking of fans coupling with bodies etc. The Supplier shall take adequate precaution and care while executing the work.

For all damage due to negligence etc. the Supplier shall be responsible to replace/repair at his own cost.
Before connecting power cables to motors the insulation resistance of all motor windings shall be measured. Measurement shall be repeated after power cable terminations are completed and before first charging.

Motors shall be operationally tested together with the starting gear and auxiliary apparatus such as push button stations, the contactors, level and pressure controls, signal and alarm apparatus, power and control circuits etc.

- Check the anti-condensation heater and its circuit (if installed)
- Check the setting of the thermal overload protection / single-phase preventer. Testing of these devices is to be done wherever required as per the instructions of the Engineer-in-charge.

All motors shall run uncoupled for a maximum period of 4 hours before the driven equipment is placed in regular service.

4.5.2 Proforma for motor testing

1. Name plate details: Voltage.... HP.... KW.... Mounting.... Current.... RPM.... Frame size.... Make.... S No.... Others.......

2. Insulation test (before cable connection).
   a. Between phase and earth ... Mega ohms.
   b. Between each phase ... Mega ohms.

3. Insulation test (after cable connection).
   a. Between phase and earth ... Mega ohms.
   b. Between each phase ... Mega ohms.

4. No load current: R Phase .....Amps.
   Y Phase .....Amps.
   B Phase .....Amps.

5. Full load current: R Phase .....Amps.
   Y Phase .....Amps.
   B Phase .....Amps.

6. Temperature rise after 4 hours run: On no load0°C. On full load 0°C.
   Ambient temperature during test 0°C.

7. Operation of thermal overload relay:
   i. At normal FL current of motor
   ii. At twice FL current of motor : trip in Seconds.

(This proforma shall be jointly signed by the Engineer-in-charge and the Supplier.)

4.6 DG Sets
4.6.1 Erection & Testing

The preassembled DG Set shall be placed over the foundation and aligned properly. Before termination of cable to the alternator, the insulation resistance of the alternator will be measured and bearings shall be checked. All pipe connections etc of the engine shall also be checked.

Also, the level of lubricant & coolant in the engine. The setting of various protection & releases, power and control circuits of the DG set panel shall be checked before switching on the DG Set.

4.6.2 Proforma for Alternator testing

1. Name plate details: Voltage.... HP.... KW.... Mounting.... Current.... RPM.... Frame size... Make.... SNo..... Others ........

2. Insulation test (before cable connection).
   a. Between phase and earth ... Mega ohms.
   b. Between each phase ... Mega ohms.

3. Insulation test (after cable connection).
   a. Between phase and earth. .. Mega ohms.
   b. Between each phase ... Mega ohms.


6. Temperature rise after 4 hours run: On no load 0°C. On full load 0°C. Ambient temperature during test 0°C.

7. Operation of thermal overload relay: At normal FL current of motor

8. No load & full load regulation:

4.6.3 Proforma for Diesel Engine testing

1. Speed regulation from no load to full load

2. Frequency at no load, 50% load & 100% load

3. Safety controls & protective devices

4. Specific fuel consumption:

5.0 INSTALLATION OF CABLE NETWORK

Cable network shall include power, control, signal & instrumentation and lighting cables which shall be laid in underground trenches, Hume pipes, open trenches, cable trays, GI/SS pipes, or on building structure surfaces as detailed in the relevant drawings, Cable schedules or as per the Engineer- in-charge's instructions. Supply & installation of cable trays, GI / SS pipes/ conduits, cable glands sockets at both ends, isolators, junction boxes, remote push buttons stations, etc. shall be under the scope of the Supplier.

5.1 General requirements for handling of cables.
5.1.1 Before laying cables, these shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000 volt Megger.

5.1.2 The cables shall be supplied at site, wound on wooden drum as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable will be rolled on, as it produces kinks, which may damage the conductor.

5.1.3 Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall be as per IS 1255-1983 and shall not be less than 10 D Where ‘D’ is overall diameter of the cable.

5.1.4 While drawing cables through GI / SS pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40 % area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.

5.1.5 High voltage (11 KV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.

5.1.6 Armoured cables shall never be concealed in walls /floors /roads without GI pipes, conduits / RCC pipes.

5.1.7 Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin type joint shall be made, without any additional cost.

5.1.8 A minimum loop of 3 M shall be provided on both ends of the cable, or after every 50 M of unjointed length of cable and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying if the contract awarded is on item rate basis.

5.1.9 Cable shall be neatly arranged in the trenches/trays in such a manner so that crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Supplier.

5.1.10 All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings are indicative only and the same may be rechecked with the Engineer-in-charge before cutting of cables. While selecting cable routes, interference with structures, foundations, pipeline, future expansion of buildings, etc. should be avoided.

5.1.11 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

5.1.12 Wherever cable rises from underground/concrete trenches to motors/switchgears/push buttons, these shall be taken in G.I. Pipes of suitable size, for mechanical protection up to 300 mm distance of concerned cable gland or as instructed by the Engineer-in-charge.

5.1.13 Where cables pass through foundation/walls of other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical Supplier shall determine their location and obtain approval of the Engineer-in-charge before cutting is done.

5.2 Laying of Cables (underground system)
5.2.1 Cables shall be so laid in ground that these will not interfere with other underground structures. All water pipes, sewage lines or other structures, which become exposed by excavation, shall be properly supported and protection from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded / diverted as directed by the Owner.

5.2.2 Cables shall be laid at minimum depth of 750 mm in case of LT & 1200 mm in case of HT, from ground level. Excavation will be generally in ordinary alluvial soil. The width of the trench shall be sufficient for laying of required number of cables.

5.2.3 Sand bedding 75 mm thick shall be made below and above the cables. A layer of bricks (full size) shall be laid on the edge, above sand bedding on the sides of cables and a flat brick to cover cable completely. More than one cable can be laid in the same trench by providing a brick on edge between two cables. However the relating location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction to the Engineer-in-charge.

5.2.4 For all underground cables, route markers should be used.
   a. Separate cable route markers should be used for LT, HT and telephone cables.
   b. Route markers should be grouted in ground with 1:2:4 cement concrete pedestal size 230 x 230 x 300 mm
   c. Cable markers should be installed at an interval not exceeding 50 M along the straight routes of cables at a distance of 0.5 M away from centre of cable with the arrow marked on the cable markers plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.

5.2.5 RCC Hume pipe for crossing road in cable laying shall be provided by Owner. No deduction shall be made for cable laying in Hume pipe for not providing bricks, sand and excavation. RCC Hume pipe at the ends shall be sealed by bituminous compound after laying and testing of cable by electrical Supplier without any extra charge.

5.3 Laying of Cables Under Floors

5.3.1 GI class 'A' pipe shall be used for laying of outgoing cables from distribution boards to motors, isolators/junction boxes of motors, starter of motors and push button stations under floors. Preferably one cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable 40 % area is free. If length of pipe is more than 30 M, free area may be increased to 50%.

5.3.2 Uses of elbows are not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe-bending machine shall be used for making long radius smooth bends at site.

5.3.3 Ends of pipe shall be sealed temporarily while laying with cotton/jute/rubber stopper etc. to avoid entry of building material.

5.3.4 Exact location of equipment motor/isolator/push buttons etc. shall be ascertained prior to laying of pipe.

5.4 Laying of Cable in Masonry Trenches

5.4.1 Masonry/concrete trenches for laying of cable shall be provided by Owner.

   However steel members such as MS angles/flats etc. shall be provided & grouted by electrical Supplier to support the cables without any extra charge. Cables shall be clamped to these supports with aluminum saddles/clamps. More than one tier of cables can be
provided in the same trench if the numbers of cables are more. If required, cable trays can also be provided in trenches.

5.4.2 Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches.

5.5 Laying of Cables in Cable Trays

5.5.1 Cable trays and supporting steel members such as MS angle/channel/flats etc. shall be provided and fixed by the Supplier.

5.5.2 Cables shall be laid in cable trays in single tier formation and cables shall be clamped with aluminum flat clamps and galvanized bolts & nuts. Cables from cable tray to individual drive, control panel, remote push button station and other miscellaneous equipment shall be dropped in GI/SS conduit.

5.5.3 Earthing flat/wire can also be laid in cable tray along with cables.

5.5.4 After laying of cables minimum 20% area shall be spare.

5.6 Laying of Cables on Building Surface/Structure

5.6.1 Such type of cable laying shall be avoided as far as possible and will be allowed only for individual cables or small group of cables, which run along structure.

5.6.2 Cables shall be rigidly supported on structural steel/masonry using individual cast/malleable iron galvanized saddles and these supports shall be approximately 400 to 500 mm for cables up to 25 mm overall diameter and maximum 1000 mm for cables larger than 25 mm. Unsightly sagging of cables shall be prevented. Only aluminum/GI clamps with GI bolts/nuts shall be used.

5.6.3 If drilling of steel structure must be resorted to, approval must be secured from the Engineer-in-charge and steel must be drilled where the minimum weakening of the structure will result.

5.7 Termination and Jointing of Cables

5.7.1 Use of Glands

All PVC cable upto 1.1 KV grade, armoured or unarmoured shall be terminated at the equipment/junction box/isolators/push buttons/control accessories/instruments, etc. by means of suitable size compression type cable glands. Armour of cable shall be connected to earth point. The Supplier shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used for approved type.

In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, close-fit holes should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

5.7.2 Use of Lugs/Sockets

All cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs/sockets.

The following is the recommended procedure for crimped joints and the same shall be followed:
a. Strip off the insulation of the cable ends with every precaution so as not to severe or damage any strand. All insulations to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.

b. The cable should be kept clean as far as possible before assembling it with the terminal/socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminum conductors, the socket should be filled with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.

c. Correct size and type of socket/ferrule/lug should be selected depending on size of conductor, and type of connection to be made.

d. Make the crimped joint by suitable crimping tool.

e. If after crimping the conductor in socket/lug, some portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape.

5.7.3 Dressing of Cable Inside the Equipment

After fixing of cable glands, the individual cores of cable shall be dressed and taken along the cable alleys/wiring trough (if provided) or shall be fixed to the panels with polyethylene straps. Cable shall be dressed in such a manner that small loop of each core is available inside the panel.

For motors of 20 HP and above, terminal box if found not suitable for proper dressing of aluminum cables, the Supplier shall modify the same without any additional cost.

Cables inside the equipment shall be measured and paid for if the contract awarded is on item rate basis.

5.7.4 Identification of Cables/Wires/Cores

After laying & pulling cable, the contractor shall provide the cable identification tags to be tied by GI wire at each end of the cable. Power cables shall be identified with red, yellow & blue PVC tapes for trip circuits identification, additional red ferrules shall be used only in the particular cores of control cable at the termination points in the switchgear/control panels and control switches.

In case of control cables all cores shall be identified at both ends by their wire numbers by means of PVC ferrules or self-sticking cable markers, wire numbers shall be as per schematic/connection drawing. For power circuit also wire numbers shall be provided if required as per the drawings of switchgear manufacturer.

5.7.5 Cable between Isolators/Junction Box & Motors/Controls.

Wherever possible Copper Conductor Armoured cables with glands shall be used between isolator/junction box (installed near motor/controls) and motors/controls. However, if terminal box of the motor or control switch is not suitable for accepting armoured cable or it is difficult to lay, multi strand copper conductor, multi-core, unarmoured flexible cable in PVC flexible conduit (steel reinforced) with flexible conduit glands shall be used.

5.7.6 Termination of cables of 6.6 kV and above shall be carried out using heat shrinkable sleeves. This termination must be no-tracking and weather resistant.

5.8 Testing of Cables

5.8.1 Before energizing, the insulation resistance of every circuit shall be measured between conductors and between each conductor and ground. This requires 3 measurements if one
side is grounded and 6 measurements for 3 phase circuits. Continuity test on each lead of cable shall also be tested.

5.8.2 Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Report measurements after splices and/or terminations are complete.

5.8.3 DC High Voltage test shall be made after installation on the following:

All 1100 Volts grade cables in which straight through joints have been made. All cables above 1100 V grade.

For record purposes test data shall include the measured values of leakage current versus time.

The DC High Voltage test shall be performed as detailed below:

Cables shall be installed in final position with the entire straight through joints complete. Terminations shall be kept unfinished so that motors, switchgear transformer etc. are not subjected to test voltage.

The test voltage and duration shall be as per relevant codes and practices of Indian Standards Institution.

5.9 Proforma for Testing Cables

DATE OF TEST

a. Drum No. From which cable taken

b. Cable from to

c. Length of run of this table meter d.

Insulation resistance test:

<table>
<thead>
<tr>
<th>Voltage of Megger</th>
<th>..................</th>
<th>Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>between core-1 to earth</td>
<td>............... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core-2 to earth</td>
<td>............... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core-3 to earth</td>
<td>............... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core 4 (neutral) to earth</td>
<td>................... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core-1 to core-2</td>
<td>............... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core-2 to core-3</td>
<td>............... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core-3 to core-1</td>
<td>............... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core 4(neutral) to core 1</td>
<td>.......... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core 4(neutral) to core 2</td>
<td>.......... Mega-ohm</td>
<td></td>
</tr>
<tr>
<td>between core 4(neutral) to core 3</td>
<td>.......... Mega-ohm</td>
<td></td>
</tr>
</tbody>
</table>

e. High voltage test Voltage Duration

between cores and earth

between individual cores

(This proforma shall be jointly signed by the Engineer-in-charge and the Supplier).

6.0 Earthing Network

The entire earthing installation shall be done in accordance with the earthing drawings, specification and instructions of the Engineer-in-charge. The entire earthing system shall fully comply with the Indian Electricity Act and Rules framed thereunder. The Supplier shall carry out any changes desired by the electrical inspector or the Owner in order to make the installation conform to the Indian Electricity Rules, at no extra cost. The exact location of the
earth pits, earth electrode and conductors and earthing points of the equipments shall be determined at site, in consultation with the Engineer-in-charge. Any change in the methods, routing, size of conductor etc shall be subject to approval of the owner/engineer-in-charge before execution.

6.1 Earth Pit with Electrode

Plate or pipe type earth electrode with earth pit shall be provided for this work unless otherwise advised by the Engineer-in-charge due to typical site conditions. Earthing electrode and pit shall be as per IS: 3043-1987 (reaffirmed 2001) - code of practice for Earthing). All earth electrodes shall preferably be driven to a sufficient depth to reach permanent moist soil.

For plate type earth pit, size of earth electrode for body earthing of equipment/electrical panels (LT/MCC/ Switch Board) shall be 600 mm X 600 mm X 6 mm GI plate whereas that for the neutral earthing of transformer, DG Set, PLC & instrumentation earth electrode shall be 600 mm X 600 mm X 3 mm Copper plate. For pipe type earth pit, size of earth electrode shall be 100 mm NB GI pipe. For ready reference, sketches for pipe and plate type earth electrode earthing pits have been shown in Annexure – III.

PRIOR APPROVAL OF THE ENGINEER-IN-CHARGE SHALL BE TAKEN FOR SELECTING TYPE OF EARTH ELECTRODE (PIPE OR PLATE).

6.1.2 Earth pit centre shall be at a minimum distance of 3 m from nearest building, unless otherwise advised. The minimum 3 m distance shall be maintained between centres of 2 earth pits.

6.1.3 Earthing electrodes for Main plant lighting panel shall be plate type with double earthing.

6.2 Earth Bus, Earthing Lead and Earth Wire/Strip

6.2.1 All electrical equipment is to be doubly earthed by connecting two-earth strip/wire conductor from the frame of the equipment to an earthing pit/main earthing ring. The earthing ring will be connected via links to several earth electrodes. The cable armoured will be earthed through the cable glands. Conductor size for connection to various equipment shall be as specified in the drawing / as instructed by the Engineer-in-charge. However, the length of the branch leads from equipment to earthing grid/ring shall not be more than 10 to 15 meters.

6.2.2 All hardware for earthing installation shall be hot dip galvanized. Spring washers shall be used for all earthing connections of equipment having vibrations.

6.2.3 Size of earthing lead / wire shall be as specified in schedule of quantities/drawings.

Following may be considered as general guidelines: Sizing of earthing lead/wire

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control switches/glands PVC insulated</td>
<td>4 sq. mm copper conductor wire</td>
</tr>
<tr>
<td>2</td>
<td>Motor /Isolators up to 10 HP</td>
<td>PVC insulated 4 sq. mm copper conductor wire</td>
</tr>
<tr>
<td>3.</td>
<td>Motor /Isolators above 10 HP</td>
<td>PVC insulated 4 sq. mm copper conductor wire up to 40 HP</td>
</tr>
<tr>
<td></td>
<td>Upto Cable tray &amp; GI strip 25 X 3 mm</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Motor above 50 HP upto 125 HP</td>
<td>GI strip 40 X 3 mm</td>
</tr>
<tr>
<td>5.</td>
<td>Motor above 125 HP</td>
<td>GI strip 25 X 6 mm</td>
</tr>
<tr>
<td>6.</td>
<td>Switch Board / Motor Control Centre</td>
<td>GI strip 50 X 6 mm</td>
</tr>
<tr>
<td>7.</td>
<td>Earthing main in trenches</td>
<td>GI strip 50 X 6 mm</td>
</tr>
<tr>
<td>8.</td>
<td>Power Control Centre / LT Panel Of Sub Station</td>
<td>GI strip 50 X 6 mm</td>
</tr>
</tbody>
</table>
When earthing wire is to be drawn under floor / in underground, Copper conductor wire of 4 sq mm with PVC insulation shall be used.

However, while deciding type & size of earth lead, the resistance between the earthing system and the general mass of the earth shall be as per IS code of practice. The earth loop impedance to any point in the electrical system shall not be in excess of 1.0 ohm in order to ensure satisfactory operation of protective devices.

6.2.4 Copper wire shall be connected to the equipment by providing crimping type socket / lug.

6.2.6 Wherever earthing strip to be provided in cable tray, it shall be suitably clamped on cable tray and electrically bonded to the cable tray at regular interval.

6.2.6 Excavating & refilling of earth, necessary for laying underground earth bus loops, shall be responsibility of the Supplier.

6.2.7 Wherever earth leads/stripswire are laid in cable trenches, these shall be firmly and suitably cleated to the walls/supporting steel structure on which cable is clamped.

6.2.8 The neutral of the transformer shall be connected to earth pit independently and earth pit shall have copper earth plate of 600 mm X 600 mm X 3 mm.

6.2.9 Long runs of GI strip shall be connected at each end with lap type welding to ensure continuity.

6.2.10 The following selection table shall be followed for starters of motor feeders unless otherwise specified:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>415 V Motor HP</th>
<th>Contactor Rating Amps</th>
<th>MCCB Rating Amp.</th>
<th>MPCB Rating Amp.</th>
<th>Type of Starter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to 3 HP</td>
<td>9</td>
<td>-</td>
<td>9</td>
<td>DOL</td>
</tr>
<tr>
<td>2</td>
<td>5 to 10 HP</td>
<td>16</td>
<td>-</td>
<td>16</td>
<td>-Do</td>
</tr>
<tr>
<td>3</td>
<td>12.5 to 15 HP</td>
<td>25</td>
<td>-</td>
<td>25</td>
<td>Star Delta</td>
</tr>
<tr>
<td>4</td>
<td>20 to 25 HP</td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>30 to 35 HP</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-Do</td>
</tr>
<tr>
<td>6</td>
<td>40 HP</td>
<td>-</td>
<td>63</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>7</td>
<td>45 HP</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>8</td>
<td>50 to 60 HP</td>
<td>-</td>
<td>125</td>
<td>-</td>
<td>Soft Starter</td>
</tr>
<tr>
<td>9</td>
<td>65 to 70 HP</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>10</td>
<td>75 to 90 HP</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>11</td>
<td>100 to 125 HP</td>
<td>-</td>
<td>250</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>12</td>
<td>150 to 180 HP</td>
<td>-</td>
<td>400</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>13</td>
<td>200 to 250 HP</td>
<td>-</td>
<td>400</td>
<td>-</td>
<td>-Do</td>
</tr>
<tr>
<td>14</td>
<td>275 to 400 HP</td>
<td>-</td>
<td>630</td>
<td>-</td>
<td>-Do</td>
</tr>
</tbody>
</table>

For capacitors, either special capacitor duty contactors shall be used or the rating of contactors / MCCB shall be double of rated current of capacitor.

- The above selection table provides the general guideline. However, technical requirement / specifications, if any mentioned under Section V, will supersede the table given above.

7.0 TWO / FOUR POLE STRUCTURE

7.1 ISMB 200 x 100 mm to be grounded in concrete 1:2:4 for at least 1/5th length i.e. 2 meters size of concrete pedestal 500x500mm. All necessary civil works such as excavation, centering, concreting and back filling is included in supplier's scope of work.

7.2 Interconnecting by aluminum conductor jumpers with connectors/PG clamps etc.
7.3 Installation, testing and commissioning of complete two/four pole structure including ISMB & cross channels, G.O. switch, insulators and other items mentioned under equipment supplied for two pole structure.

7.3 Complete structure to be provided with two coats of aluminum paint.
### BUREAU OF INDIAN STANDARDS TO BE FOLLOWED FOR ELECTRICAL ERECTION

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PVC insulated cables (light duty) for Working voltage up to 1100 V</td>
<td>694-1990</td>
</tr>
<tr>
<td>2.</td>
<td>PVC insulated cables (heavy duty) for Voltage up to 1100 volts</td>
<td>1554-1988</td>
</tr>
<tr>
<td>3.</td>
<td>-- do -- for voltage 3.3 KV to 11 KV</td>
<td>1554-1988</td>
</tr>
<tr>
<td>4.</td>
<td>Specification for polyethylene insulated PVC - Sheathed heavy duty electric cables, voltage not exceeding 1100 V</td>
<td>5959-1970</td>
</tr>
<tr>
<td>5.</td>
<td>-- do -- voltage 3.3 KV to 11 KV Part II</td>
<td>5959-1970</td>
</tr>
<tr>
<td>7.</td>
<td>Code of practice for installation and Maintenance of power cables up to 33 kV</td>
<td>1255-1983</td>
</tr>
<tr>
<td>15.</td>
<td>Code of practice for electrical wiring Installation (system voltage exceeding 650 V)</td>
<td>2274-1963</td>
</tr>
<tr>
<td></td>
<td>Guide for testing three-phase induction</td>
<td>4029-1967</td>
</tr>
<tr>
<td></td>
<td>Motor</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>XLPE Cables for working voltage up to And including 1100 Volts</td>
<td>7098     – 1988 Part I</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Code</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>19.</td>
<td>up to 33 kV</td>
<td>7098–1988 Part II</td>
</tr>
<tr>
<td>20.</td>
<td>Boxes for enclosures of electrical accessories</td>
<td>5133</td>
</tr>
<tr>
<td>21.</td>
<td>Electric Power connectors</td>
<td>5561</td>
</tr>
<tr>
<td>22.</td>
<td>HRC Cartridge Fuse Link up to 650 V</td>
<td>2208</td>
</tr>
<tr>
<td>23.</td>
<td>Code of Practice for Selection, Installation &amp; Maintenance of Fuse up to 650 V</td>
<td>3108</td>
</tr>
<tr>
<td>24.</td>
<td>Cables methods of testing</td>
<td>10810</td>
</tr>
<tr>
<td>25.</td>
<td>Danger / Lattice Boards</td>
<td>3551</td>
</tr>
</tbody>
</table>
## RECOMMENDED CABLES SIZES FOR INDUSTRIAL WIRING

The following selection table shall be followed for cables of motors unless otherwise specified:

### 3 Phase 415 V Motor H.P

<table>
<thead>
<tr>
<th>3 Phase 415 V Motor H.P</th>
<th>Aluminum Conductor Cable Size- Sq. mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DOL Starter/Soft starter Star- Delta Starter</td>
</tr>
<tr>
<td></td>
<td>Supply side</td>
</tr>
<tr>
<td>Up to 7.5</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>16</td>
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<tr>
<td>200</td>
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<td>275</td>
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<tr>
<td>300</td>
<td>2X240</td>
</tr>
<tr>
<td>425</td>
<td>2X400</td>
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</table>

<table>
<thead>
<tr>
<th>3 Phase 415 V Motor H.P</th>
<th>Copper Conductor Cable Size- Sq. mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DOL Starter/Soft starter Star- Delta Starter</td>
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<tr>
<td></td>
<td>Supply side</td>
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<td>185</td>
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<td>180</td>
<td>240</td>
</tr>
<tr>
<td>200</td>
<td>2X120</td>
</tr>
<tr>
<td>250</td>
<td>2X150</td>
</tr>
<tr>
<td>275</td>
<td>2X185</td>
</tr>
<tr>
<td>300</td>
<td>2X185</td>
</tr>
<tr>
<td>425</td>
<td>2X240</td>
</tr>
</tbody>
</table>

In case LAPP/Concab / Equi design of steel braided Copper Cables are used then Minimum size for various rating of motors to be laid between MCC & motors shall be as given in the table below:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Motor ratubg HP</th>
<th>Full Load Current (Amp.)</th>
<th>Type of Starter</th>
<th>Power cable rating (At Amb. Temp. of 45 sq.mm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>0.75</td>
<td>1.3</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1.9</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>2.6</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>3.7</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>4.8</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>5.2</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>7.8</td>
<td>DOL</td>
<td>3 C or 4 C x 1.5 sq. mm</td>
</tr>
<tr>
<td>9</td>
<td>7.5</td>
<td>11.2</td>
<td>DOL</td>
<td>3 C or 4 C x 2.5 sq. mm</td>
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<tr>
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<td>10</td>
<td>16</td>
<td>DOL</td>
<td>3 C or 4 C x 2.5 sq. mm</td>
</tr>
<tr>
<td>11</td>
<td>12.5</td>
<td>19</td>
<td>Star delta starter</td>
<td>3 C pr 4 C x 4 sq. mm (2 runs)</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td>20.8</td>
<td>Star delta starter</td>
<td>3 C pr 4 C x 4 sq. mm (2 runs)</td>
</tr>
<tr>
<td>13</td>
<td>20</td>
<td>28</td>
<td>Star delta starter</td>
<td>3 C pr 4 C x 6 sq. mm (2 runs)</td>
</tr>
<tr>
<td>14</td>
<td>25</td>
<td>34</td>
<td>Star delta starter</td>
<td>3 C pr 4 C x 10 sq. mm (2 runs)</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>40</td>
<td>Star delta starter</td>
<td>3 C pr 4 C x 10 sq. mm (2 runs)</td>
</tr>
<tr>
<td>16</td>
<td>40</td>
<td>53</td>
<td>Star delta starter</td>
<td>3 C pr 4 C x 16 sq. mm (2 runs)</td>
</tr>
<tr>
<td>17</td>
<td>50</td>
<td>65</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 25 sq. mm</td>
</tr>
<tr>
<td>18</td>
<td>60</td>
<td>78</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 35 sq. mm</td>
</tr>
<tr>
<td>19</td>
<td>75</td>
<td>96</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 50 sq. mm</td>
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<tr>
<td>20</td>
<td>100</td>
<td>131</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 70 sq. mm</td>
</tr>
<tr>
<td>21</td>
<td>125</td>
<td>156</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 120 sq. mm</td>
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<tr>
<td>22</td>
<td>150</td>
<td>189</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 150 sq. mm</td>
</tr>
<tr>
<td>23</td>
<td>180</td>
<td>227</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 185 sq. mm</td>
</tr>
<tr>
<td>24</td>
<td>215</td>
<td>271</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 240 sq. mm</td>
</tr>
<tr>
<td>25</td>
<td>250</td>
<td>325</td>
<td>Soft starter</td>
<td>3 C pr 4 C x 300 sq. mm</td>
</tr>
<tr>
<td>26</td>
<td>275</td>
<td>360</td>
<td>Soft starter</td>
<td>3 C or 4 x 185 sq. mm-2 runs</td>
</tr>
<tr>
<td>27</td>
<td>300</td>
<td>390</td>
<td>Soft starter</td>
<td>3 C or 4 x 185 sq. mm-2 runs</td>
</tr>
<tr>
<td>28</td>
<td>335</td>
<td>400</td>
<td>Soft starter</td>
<td>3 C or 4 C x 240 sq. mm-2 runs</td>
</tr>
<tr>
<td>29</td>
<td>375</td>
<td>NA</td>
<td>Soft starter</td>
<td>3 C or 4 C x 300 sq. mm-2 runs</td>
</tr>
</tbody>
</table>

Note: Cables for motors above 20 HP have been indicated considering soft starters.

For motor rating, 200 HP and above, suitable rating of Bus Duct shall have to be provided depending upon the site requirement / as per the Site Engineer’s direction.