AN ISO 9001 & 14001 COMPANY

TENDER DOCUMENT

TENDER No: WRO/ CON/ 030-C/ 0217

Air Conditioning Work for Teaching Hospital for the New Govt. Medical College at Balasore, Odisha

VOLUME - II

Additional Conditions of Contract General, Client Conditions, Technical Specifications & General Conditions of Contract
## ADDITIONAL CONDITIONS OF CONTRACT (ACC)

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<th>1. <strong>General:</strong></th>
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<td>The Additional Conditions shall be read in conjunction with General Conditions of Contract. Where the provisions of these Additional Conditions are at variance with the provision of the EPI General Conditions of Contract, the provisions of these Additional Conditions shall take precedence for EPI GCC only. Client GCC may precede ACC and EPI GCC.</td>
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<th>2. <strong>Commencement and Completion of Project:</strong></th>
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<td>The Contractual Completion Period shall be 24 months from the 10th day of issue of Letter of Intent of Acceptance of Tender.</td>
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| 4. **Price quoted is to be inclusive of all duties, taxes, excluding GST including Building and other Construction Workers Welfare Cess @ 1% payable by the contractor under the contract, or for any other cause shall be included in the rates, prices submitted by the bidder. Taxes on material in respect of this contract shall be payable by the Contractor and Government will not entertain any claim whatsoever in respect of the same except GST payable for works contract. Contract price shall be adjusted for increase or decrease in rates and price of Labour, Cement, Steel, Bitumen, Pipes, POL & other material component in accordance with the following principles and procedures as per formula Vide Works Department Memorandum No-12606 /W dt. 24.12.2012 as given in clause no. 36 in client conditions of contracts.** |

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<th>5. <strong>Taxes and Duties:</strong></th>
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<td>The following shall be also read with clause no 13 of GCC:</td>
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<td>1. The bidder/Contractor must be registered with GST for Odisha and should have valid GSTIN number.</td>
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<td>2. The bidder/contractor must submit as an compliances of GST Act, the invoices in GST compliant format failing which the GST amount shall be recovered/ adjusted by EPI without any prior notice from the next invoices or available dues with EPI.</td>
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<tr>
<td>3. The bidders/contractors are requested to update/upload the GST/Taxes data periodically so as to avail ITC credit by EPI failing which it shall be recovered/adjusted by EPI without any prior notice from the next invoices or available dues with EPI.</td>
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4. Rates to be quoted in this tender all-inclusive with all other taxes and duties etc. excluding GST

5. Bidder while quoting the rates in the tender must also consider the ITC credit applicable for the works, if any.

6. **LAND FOR LABOUR HUTS/ SITE OFFICE AND STORAGE ACCOMMODATION**
   
   In addition to GCC Clause no 28.1,
   It is bidder responsibility to acquire the land for on its own cost of following
   1. Labour Hutment
   2. Storage of Material
   3. Cement Godown
   4. Storage unit
   5. Site Establishment

7. **WATER AND ELECTRICITY**

   The Contractor shall make his own arrangement for Water & Electrical power for construction and other purposes at his own cost and in case EPIL provides electricity and water charges shall be deducted. The Contractor shall also make standby arrangement for water &electricity to ensure un-interrupted supply.

8. **Secured Advance:**

   GCC Cl no. 35 **DELETED** - No Secured Advance for this tender

9. **Payment:**

   RA Bill must be accomplish by progress photos, All other terms of GCC Cl no 37.2 remains same.

   Payment shall be released to contractor after release of respective payment from client only.

   In addition to clause no 37.2 of GCC, all payment shall be released by NEFT/RTGS

10. **Bar Chart:**

    The Contractor shall also furnish within 10 days from the date of letter of Intent, a Bar Chart on MS Projects for completion of work with in stipulated time. This will be duly got approved from EPI. This approved MSP Chart shall form a part of the agreement. Achievement of milestones as well as total completion has to be within the time period allowed.
### 11. Works to Be Open to Inspection:

All works executed or under the course of execution in pursuance of this contract shall at all times be open to inspection and supervision of EPI. The work during its progress or after its completion may also be inspected, by Chief Technical Examiner of Government of India (CTE) and/or an inspecting authority of State Government of State in which work is executed and/or by third party checks by Owner/ Clients. The compliance of observations/ improvements as suggested by the inspecting officers of EPI/CTE/ State authorities/ Owners shall be obligatory on the part of the Contractor at the cost of Contractor. 

*Any recovery, penalty imposed by CTE due to non-performance, non-compliance of agreed condition or otherwise whatsoever the same shall be recovered from RA Bill of contractor.*

### 12. Materials Procured With the Assistance of EPI:

If any material for the execution of this contract is procured with the assistance of EPI either by issue from its stores or purchase made under orders or permits or licenses obtained by EPI, the Contractor shall hold and use the said materials economically and solely for the purpose of this contract and shall not dispose them without the written permission of Engineer-In-Charge. The Contractor, if required by EPI, shall return all such surplus or unserviceable materials that may be left with him after the completion of the contract or at its termination on whatsoever reason, on being paid or credited such price as EPI shall determine having due regard to the conditions of materials.

*All the materials are deemed to be in scope of contractor and shall be arranged by him, however if any such material is procured with assist of EPI, a handling charges of 10% on plus GST actual purchase cost shall be levied and recovered from RA bills of contractors.*

### 13. Defect Liability Period:

12 months after completion of this work against certification from site I/C

### 14. Arbitration:

General Conditions of Contract (GCC) Sub Clause no.76.1 and 76.3 of Arbitration Clause no.76.0 are amended as given below. Sub Clause no.76.2 will remain the same.

76.0 ARBITRATION
76.1 Before resorting to arbitration as per the clause given below, the parties if they so agree may explore the possibility of conciliation as per the provisions of Part III of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation
When such conciliation has failed, the parties shall adopt the following procedure for arbitration:

i) Except where otherwise provided for in the contract, any disputes and differences relating to the meaning of the Specifications, Design, Drawing and Instructions herein before mentioned and as to the quality of workmanship or materials used in the work or as to any other questions, claim, right, matter or things whatsoever in any way arising out of or relating to the Contract, Designs, Drawings, Specifications, Estimates, Instructions, or these conditions or otherwise concerning the works of the execution or failure to execute the same whether arising during the progress of the work or after the completion or abandonment thereof shall be referred to the Sole Arbitrator appointed by the Chairman & Managing Director (CMD) of Engineering Projects (India) Limited (EPI) or any other person discharging the functions of CMD of EPI. The person approached for appointment as Arbitrator shall disclose in writing circumstances, in terms of Sub-Section (1) of Section (12) of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation (Amendment) Act, 2015 as follows:

a) such as the existence either direct or indirect, of any past or present relationship with or interest in any of the parties or in relation to the subject-matter in dispute, whether financial, business, professional or other kind, which is likely to give rise to justifiable doubts as to his independence or impartiality; and

b) which are likely to affect his ability to devote sufficient time to the arbitration and in particular his ability to complete the entire arbitration within a period of twelve months. The Arbitrator shall be appointed within 30 days of the receipt of letter of invocation of arbitration duly satisfying the requirements of this clause.

ii) if the arbitrator so appointed resigns or is unable or unwilling to act due to any reason whatsoever, or dies, the Chairman & Managing Director aforesaid or in his absence the person discharging the duties of the CMD of EPI may appoint a new arbitrator in accordance with these terms and conditions of the contract, to act in his place and the new arbitrator so appointed may proceed from the stage at which it was left by his predecessor.

iii) It is a term of the contract that the party invoking the arbitration shall specify the dispute/ differences or questions to be referred to the Arbitrator under this clause together with the amounts claimed in respect of each dispute.

iv) The Arbitrator may proceed with the arbitration ex-parte, if either party, in spite of a notice from the arbitrator, fails to take part in the proceedings.
v) The work under the contract shall continue as directed by the Engineer-In-Charge, during the arbitration proceedings.

vi) Unless otherwise agreed, the venue of arbitration proceedings shall be at the venue given in the ‘Memorandum’ to the ‘Form of Tender’.

vii) The award of the Arbitrator shall be final, conclusive and binding on both the parties.

viii) Subject to the aforesaid, the provisions of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation (Amendment) Act, 2015 or any statutory modifications or re-enactment thereof and the Rules made there under and for the time being in force shall apply to the arbitration proceedings and Arbitrator shall publish his Award accordingly.

76.3 JURISDICTION:
The courts in Mumbai alone will have jurisdiction to deal with matters arising from the contract.

15. **Furnished Office Accommodation & Mobility and Communication to be provided by the Contractor to EPI:**

GCC clause no. 28.3 is Deleted

16. **Insurance:**

In addition to GCC clause no. 17 is modify as under

EPI shall take Contractor All Risks (CAR) policy for the whole project. THE CONTRACTOR shall assist EPI in follow up with insurance company in case of any claim related to CONTRACTOR’s scope of work. EPI is not liable to pay any claim of the CONTRACTOR of it is not paid by insurance company due to any reasons whatsoever.  

Workmen’s Compensation Policy  
Contractor has to obtain workmen compensation Policy for the scope of work till completion of project

17. **Labour:**

The Contractor shall, unless otherwise provided in the GCC Clause reference, make his own arrangements for the engagement of all staff and labour, local or other, and for their payment, housing, feeding and transport.

The contractor shall, if required by the Engineer, deliver to the Engineer a return in detail, in such form and at such intervals as the Engineer may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such other information as the Engineer may require.
The CONTRACTOR shall also be responsible for labour welfare and for arranging labour and other licenses/permits/clearance etc. for the project at their own. In case EPI has to take labour license or and other licenses, all expenditure towards the same shall also be borne by the CONTRACTOR. The CONTRACTOR shall comply with all the requirements as per labour laws/acts. All the records in this regard shall be maintained by CONTRACTOR as per statutory requirements and rules and shall be produced by the CONTRACTOR on demand if required.

18. The CONTRACTOR shall be fully responsible to complete the “Works” in workmen like manner to the satisfaction of the Client and EPI by maintaining high standard of quality and precision as per ‘Tender Documents,’ Agreements, Terms & Conditions, Specifications, Drawings etc. within contractual completion period and within their quoted rates/ amount. The rates quoted/finalized shall remain firm throughout till completion of works including the extend period for which Extension shall be granted by EPI without Levy of L.D & in no case rate shall be revised.

19. In case the project execution is delayed beyond the contractual scheduled completion period due to any reason attributable to the Contractor, the staff and site office expenses of EPI for extended period shall be paid by the contractor as per 113: Time Control of Client GCC.

20. The CONTRACTOR shall be responsible for obtaining all approvals from Client with regard to quality of materials & workmanship and measurements etc. for their portion of work. All such approvals shall be in the name and title of EPI. The CONTRACTOR shall be responsible for reconciliation of issued materials as per CPWD norms. Any shortfall in issue materials shall be made good/recovered from CONTRACTOR at actual expenditure.

21. The CONTRACTOR will not deal directly with Client and all the correspondence in matters regarding bills, claims, interpretation of the specifications, conditions and all matters related to the contract with Client, Client’s Consultants, all other agencies including Government and Statutory bodies etc. shall be done through EPI only. CONTRACTOR shall prepare and submit expeditiously all bills, claims, details, clarifications, documents, information, etc. as required by EPI /Client for proper execution and successful completion of the “Works”.

22. If desired by EPI, CONTRACTOR shall be available/associate with EPI in meetings with Client for its portion of work. CONTRACTOR shall furnish all information and clarifications as and when required by EPI/Client.

23. The CONTRACTOR shall plan and execute the “Works’ in his scope of work in such a manner that the other works, connected with the “Works” of the CONTRACTOR, but not included in the CONTRACTOR’s scope of work, do not get affected/delayed.
24. The CONTRACTOR shall deploy sufficient plant & equipment of the required and in good working condition for completion of the works in stipulated time with required quality, the equipment should either be owned by the CONTRACTOR or hired/leased. The deployment of equipment by CONTRACTOR shall be as decided by EPI and the same shall not be less than the minimum deployment stipulated by the Client, if any for execution of “Works” and as per schedule agreed with EPI. The CONTRACTOR shall make arrangement for regular maintenance including preventive and breakdown maintenance and maintain stock of essential spares at site/near to site so as to ensure minimum breakdown time of equipment. The equipment once brought to site shall not be allowed to be removed without the consent of EPI. In case the CONTRACTOR fails to deploy sufficient equipment to the satisfaction of EPI or in case of prolonged breakdown of equipment, EPI at its sole discretion shall arrange the required equipment and debit all the related costs including 10% overheads of EPI and shall recover the same from the due payments of CONTRACTOR, including from its bank guarantees Retention money /other dues available with EPI.

25. **Priority of Work:**

The contractor has to deploy resources and plan the work accordingly and nothing extra shall be payable to the contractor on this account. The contractor has to ensure safety of the occupants and sufficiently barricade the area so as to avoid any hazard to occupants.

27. If any tenderer withdraws his tender before the said period or issue of letter of acceptance/intent, whichever is earlier, or makes any modifications in the terms and conditions of the downloaded tender which are not acceptable to the EPIL, then the EPIL shall, without prejudice to any other right or remedy, be at liberty to forfeit entire amount of Earnest Money as aforesaid.

26. The final bill will be submitted by the contractor within 60 days from the date of acceptance of completion of work accompanied by the following documents:

a) Completion certificate issued by the Engineer-in-Charge specifying the handing over of the work including list of inventories (fittings & fixtures)

b) Computerized stage wise payment schedule.

c) No claim certificate by the contactor.

d) No claim certificate from the sub-agencies / venders engaged by the contractor.

e) As built’ drawings.

f) Periodical services and measurement books.

g) Drawings for layout of underground cables and details showing location of sluice
valves, electric cable joints etc.

h) All operation and maintenance manuals.

i) All statutory approvals from various state / central govt. local bodies, if required for completion & handing over of the work as included in scope of Contractor.

j) Manufacture’s guarantee of various machines / equipment’s installed as part of works.

k) NOC from labour department, PF Department.

27. The EPI at its discretion issue the Reinforcement Steel (TMT bars) in each lot on the basis of actual weighment. It should be clearly understood that irrespective of the METHODOLOGY adopted for issuing the material, the Contractor shall have no claim whatsoever, on account of the time and cost involved in issue, accounting, stacking, transporting, loading and unloading, reconciliation etc. of EPIL issue material.

Unloading of Reinforcement Steel at site will be the responsibility of the Contractor & shall be done its own cost. Reinforcement Steel (TMT bars) to be issued by EPI shall be collected/delivered in such condition and in such length/weight/size as are available/received from manufacturers. Reinforcement steel shall be stored and stacked in such a manner so as to facilitate easy identification, removal etc. The Party shall take proper care to prevent direct contact between the steel and the ground for which he shall provide at his own cost drainage and packages as per direction of the Engineer-in-Charge. The party shall maintain a proper store account for all the EPIL issue material and shall give a copy of the monthly statement of such accounts to EPI. Consumption reconciliation shall be done along with each bill and to attach Reconciliation statement along with each bill. CPWD specification shall be followed for permissible variation and recovery rates for quantities beyond permissible variation shall be as per prevailing market rate.

The party shall solely be responsible for the safety, quality and quantity of the material after it is issued by EPIL against Indemnity bond format as per GCC.

28. All the tests other than the field test which are to be done as per tender document and specifications will be arranged by the respective party and all expenses etc. shall be borne by the respective party and nothing will be paid/reimbursed to party by EPI.
## Requirement of Technical Staff

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<th>Number</th>
<th>Minimum experience (Years)</th>
<th>Rate of recovery in case compliance</th>
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<td>(i) Project Manager with degree in Mechanical Engineering Experience in Building works</td>
<td>1</td>
<td>10</td>
<td>Rs. 50,000/-p.m.</td>
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<tr>
<td>(ii) Graduate Engineer or Diploma Engineer for supervision &amp; QC</td>
<td>2</td>
<td>5</td>
<td>Rs. 25,000/- p.m.</td>
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<tr>
<td>(iii) Supervisors</td>
<td>Sufficient</td>
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ENGINEERING PROJECTS (INDIA) LIMITED
(A Govt. of India Enterprise)

INSTRUCTIONS TO TENDERERS
ENGINEERING PROJECTS (INDIA) LIMITED

(A Govt. of India Enterprise)

INSTRUCTIONS TO TENDERERS

1.0 MODE OF SUBMISSION

The Tender is to be submitted in two separate sealed covers marked as under:

ENVELOPE-1 :-

This ENVELOPE shall contain the following:

i) Earnest Money Deposit as per clause 2.0 of ‘Instructions to Tenderers’ (ITT).

ii) Letter of Undertaking for un-conditional acceptance of the tender conditions as per proforma given in ITT.

iii) Pre-Qualification Documents and Credentials as per clause 19.0 of ITT.

iv) Volume-I (ITT, General Conditions of Contract),

   Volume-II (Notice Inviting Tender, Additional Conditions of Contract, Specifications, Drawings) and Corrigendum/ Addendum, if any, duly filled in, signed and stamped on each page by tenderer. Cutting or over-writing, if any, shall be signed and stamped by the person signing the Tender. All pro-forma forming part of Tender Documents shall be filled in, signed and stamped by the tenderer.

v) Copy of power of attorney / partnership deed, duly attested by Notary Public authorizing the person who signs the Tender.

vi) Any other information as required to be submitted along-with the Tender.

This envelope shall be marked as:

ENVELOPE-1 “TECHNO-COMMERCIAL BID” FOR (Name of work as mentioned in “Notice Inviting Tender”)

NIT No. : __________________________________________
DUE ON : __________________________________________
FROM : (Name of the Contractor)

ENVELOPE – 2 :-

This ENVELOPE shall contain only the Volume-III comprising of PRICE-BID.

This envelope shall be marked as:

ENVELOPE-2 : ‘PRICE-BID’ FOR (Name of Work as mentioned in “Notice Inviting Tender”)

NIT No. : __________________________________________
DUE ON : __________________________________________
FROM : (Name of the Contractor)
Both the envelopes / packets shall be individually sealed and kept in an outer envelope marked as:

TENDER FOR (Name of Work as mentioned in “Notice Inviting Tender”)
NIT No. : ____________________________
DUE ON : ____________________________
FROM : (Name of the Contractor)

The outer envelope shall be duly sealed and shall be delivered at place of submission of Tender by the date and time fixed for receipt of Tender as mentioned in “Notice Inviting Tender”. The Tenders received after the date and time of Tender receipt shall not be considered and shall be returned to the tenderer unopened. EPI shall not be responsible for any postal or other delays, whatsoever and tenderer should take care to ensure the submission of Tender at place of receipt of Tender by due date and time fixed for Tender receipt. All the envelopes shall be addressed to the authority who has invited the Tender as mentioned in “Notice Inviting Tender”.

1.1 First the Envelope-1 of the tenderer shall be opened. Tenderers who unconditionally accept the tender conditions, deposit the required Earnest Money and whose Techno-Commercial Bid along with PQ Documents is found suitable shall be considered for the opening of their Price Bid and Envelope-2 of such tenderers shall only be opened. The Tenders not accompanied by requisite Earnest Money and / or not conveying un-conditional acceptance of tender conditions or whose Techno-Commercial Bid and PQ Documents are not found suitable, shall be rejected and such tenderer shall not be allowed to attend Price Bid opening i.e. opening of Envelope-2.

1.2 Once the tenderer has given an unconditional acceptance to the tender conditions in its entirety, he is not permitted to put any remark(s) / condition(s) (except unconditional rebate on price, if any) in / along with the ‘Price-Bid’ / Tender.

1.3 In case the condition 1.2 mentioned above is found violated at any time after opening of Tender, the Tender shall be summarily rejected and EPI shall, without prejudice to any other right or remedy, be at liberty to forfeit the full said Earnest Money absolutely.

2.0 EARNEST MONEY DEPOSIT

Earnest Money Deposit of amount as mentioned in “NIT/ITT/Memorandum” to “Form of Tender” required to be submitted alongwith the Tender shall be in the form of Demand Draft payable at place as mentioned in “NIT/ITT” in favour of EPI Limited from any Nationalized / Scheduled Bank or in the form of Bank Guarantee from any Nationalized / Scheduled Bank in enclosed format. The EMD Bank Guarantee shall be valid for a minimum period of 150 (One Hundred Fifty) days from last day of submission of Tender. The EMD shall be governed by Clause 7.0 of General Conditions of Contract.

3.0 EPI reserves the right to reject any or all the Tenders in part or full without assigning any reason whatsoever thereof. EPI does not bind themselves to
accept the lowest Tender. EPI reserves the right to award the work to a single party or to split the work amongst two or more parties as deemed necessary without assigning any reason thereof. The Contractor is bound to accept the portion of work as offered by EPI after split up at the quoted / negotiated rates.

4.1 **FOR ITEM RATE TENDERS**

4.1.1 The tenderers should quote the rates for items tendered by them in figures as well as in words and the amounts in figures only. The amount for each item should be worked out and the requisite totals and page totals given.

4.1.2 All corrections/cuttings should be signed by the tenderer. Each page of the Tender should be signed by the tenderer. In the event of discrepancy between rate in figures and words the rate quoted in words shall be treated as correct. In case there is discrepancy between rate and amount worked out, the rate quoted shall be taken as correct and not the amount.

4.1.3 Price shall be entered against each item in Bill of Quantities where quantities or LS (lump-sump) has been mentioned. The cost of item against which the Contractor has failed to enter a rate or price shall be deemed to be covered by rates and prices of other items in the Bill of Quantities and no payment shall be made for the quantities executed for items against which rate has not been quoted by Contractor. No rate is to be quoted against items for which no quantity is given. However, the Contractor has to quote rate against "LS" items.

4.2 **FOR PERCENTAGE RATE TENDERS**

4.2.1 In case of Percentage Rate Tenders, tenderer shall fill up in the Schedule / Bill of Quantities, percentage Below/Above/Par (in figures as well as in words) to total estimated cost given in Schedule / Bill of Quantities, he will be willing to execute the work. The tenderer should quote a unique single percentage plus / minus over the total estimated amount given in Schedule / Bill of Quantities. In case more than one schedule is given, stipulating quoting of separate percentages (plus or minus) over the estimated amount of each schedule, the tenderer can quote separate percentages for each such schedule. Under no circumstances, tenderer is allowed to quote separate percentages for individual items, trades or group of items. In case tenderer quotes separate percentages for individual items, trades or group of items instead of to the total amount of schedule(s), the Tender shall be rejected and earnest money of the tenderer shall be forfeited in totality.

4.2.2 In case of Percentage Rate Tenders, the tenderer shall also work out the total amount of his offer after adding percentage (plus or minus) over the total schedule amount and the same should be written in figures as well as in words in such a way that no interpolation is possible.

4.2.3 In case of Percentage Rate Tenders, only percentage quoted shall be considered. Any tender containing item rates is liable to be rejected. Percentage quoted by the tenderer in Percentage Rate Tender shall be accurately filled in figures and words. All corrections/cuttings should be signed by the tenderer. Each page of the Tender should be signed by the tenderer. In the event of discrepancy between percentage rate in figures and words, the percentage rate
quoted in words shall be treated as correct. In case there is discrepancy between percentage rate and amount worked out the percentage rate quoted shall be taken as correct and not the amount. For any other discrepancy, the decision of Tender Scrutiny Committee of EPI shall be final & binding on the tenderer including rejection of Tender and forfeiture of EMD.

5.0 The Tenders shall be strictly as per the conditions of contract. Tenders with any additional condition(s)/modification(s) shall be rejected.

6.0 The witnesses to the Tender / Contract Agreement shall be other than the tenderer / tenderers competing for this work and must indicate full name, address, status/occupation with dated signatures.

7.0 The acceptance of Tender will rest with EPI. Tenders in which any of the prescribed conditions are not fulfilled or found incomplete in any respect are liable to be rejected.

8.0 Canvassing whether directly or indirectly in connection with Tenders is strictly prohibited and the Tenders submitted by the Contractors who resort to canvassing will be liable to rejection.

9.0 On acceptance of Tender, the name of the accredited representative(s) of the Contractor who would be responsible for taking instructions from Engineer-In-Charge or its authorised representative shall be intimated by the Contractor with in 07 days of issue date of telegram / letter / telex / fax of Intent by EPI.

10.0 The tenderer shall not be permitted to Tender for works if his near relative is posted as an Assistant Manager or any higher ranks in the concerned Regional Office of EPI. The Contractor shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any of the officers in EPI. Any breach of this condition by the tenderer would render him liable to the withdrawal of the work awarded to him and forfeiture of Earnest Money and Security Deposit. This may also debar the Contractor from tendering for future works under EPI.

11.0 No employee of EPI of the rank of Assistant Manager and above is allowed to work as a Contractor or as an employee of a Contractor having interest in EPI for a period of two years after his retirement/relief from the service of EPI, without the prior permission of EPI in writing. This contract is liable to be cancelled if either the Contractor or any of his employee is found at any time to be such a person who had not obtained the permission of EPI as aforesaid before submission of the Tender or engagement in the Contractor’s service.

12.0 The time of completion of the entire work, as contained in contract shall be as mentioned in “Memorandum” to “Form of Tender”, which shall be reckoned from the 10th day from issue of the Letter / Telex / Telegram / Fax of Intent by the EPI.

13.0 The Tender award, execution and completion of work shall be governed by Tender Documents consisting of (but not limited to) Letter of Intent / Letter of work Order, Bill of Quantities, Additional Conditions of Contract, General Conditions of Contract, Specifications, Drawings, etc. The tenderers shall be
deemed to have gone through the various conditions and clauses of the Tender and visited the Site and satisfied itself with Site conditions including sub-soil water conditions, topography of the land, drainage and accessibility etc. or any other condition which in the opinion of Contractor will affect his price / rates before quoting their rates. No claim whatsoever against the foregoing shall be entertained by EPI.

14.0 The Drawings given with the Tender Documents are TENDER DRAWINGS and are indicative only.

15.0 Transfer of bid documents purchased by one intending bidder to another is not permissible.

16.0 Tenders must be duly signed with date and sealed. An attested copy of power of attorney/affidavit/Board Resolution executed as under shall accompany the 'Tender Documents'.

a) In case of Sole Proprietorship, an affidavit of Sole Proprietorship and if the Tender is signed by any other person Power of Attorney by the Sole Proprietor in favour of signatory.

b) In case of Partnership firm, if Tender is not signed by all the partners, Power of Attorney in favour of the Partner/person signing the tender/documents by all the partners authorizing him to sign the tender/documents.

c) In case of Company, copy of the Board Resolution authorizing the signatory to sign on behalf of the Company.

17.0 Tenders with following discrepancies are liable for rejection:-

a) Tenders with over-written or erased rates, percentages, amounts or rates, percentages not written in both figures and words.

b) Tender that is incomplete, ambiguous, and not accompanied by the documents asked for or submitted without EMD or with inadequate EMD.

c) Tender received after specified date/time whether due to postal or other delays.

d) Tender in respect of which canvassing in any form is resorted to by the tenderer whatsoever.

e) If the tenderer deliberately gives wrong information in his tender or resorts to unfair methods in creating circumstances for the acceptance of his tender, EPI reserves the right to reject such tender at any stage.

18.0 Submission of a tender by the tenderer implies that he has read the complete contract documents and has made himself aware of the scope, terms & conditions and specifications of the work to be done and of conditions at which stores, tools, plant, etc. will be issued to him by EPI (if any), local conditions and
political situations and other factors having bearing on the execution of the works. No claim of Contractor whatsoever, within the purview of this clause, shall be entertained at any stage of the project.

19.0 Tenderer shall submit the following documents along with their Tenders in the first envelope (Techno-Commercial Bid):

   a) List of works executed during the last 5 years indicating name of the Client, value, date of start and completion.
   b) List of works under execution indicating name of the Client, Total Contract Value, Value of balance work in hand, date of start and completion.
   c) Details of similar works executed.
   d) Audited balance sheets and profit and loss accounts along with schedules for the last 3 years.
   e) Copy of latest income-tax returns filed along with PAN.
   f) Details of manpower available.
   g) Details of equipments, tools and plant available.
   h) Credentials and completion certificates.
   i) Registration Certificate/Memorandum and Articles of Association/Partnership Deed/Affidavit.
   j) Copy of Provident Fund Number allotted by PF authorities.
   k) Copy of letters of registration with various authorities like CPWD, State PWD, MES and Public Sector Undertakings, etc.
   l) Latest Solvency certificate from Nationalised/Scheduled Bank.
   m) Latest Sales Tax Registratin and Clearance Certificate.
   n) Any other document as stipulated above and in “Tender Documents’

20. Purchase Preference may be granted to the Central Public Sector Enterprises as per the applicable guidelines in force in this regard issued by the Government of India.
LETTER OF UNDERTAKING

(TO BE ENCLOSED IN ENVELOPE-1 ALONGWITH EMD)

ENGINEERING PROJECTS (INDIA) LIMITED
(Address of submission as mentioned in “Notice Inviting Tender”)

REF. : TENDER FOR (Name of Work as mentioned in “Notice Inviting Tender”)

NIT No. : ________________________________

Sir,

UNDERTAKING FOR ACCEPTANCE OF TENDER CONDITIONS

1. The Tender Documents for the work as mentioned in “Memorandum” to “Form of Tender” have been issued to me / us by ENGINEERING PROJECTS (INDIA) LIMITED and I / We hereby unconditionally accept the tender conditions and Tender Documents in its entirety for the above work.

2. The contents of clause 1.2 and 1.3 of the Tender Documents (Instructions to Tenderers) have been noted wherein it is clarified that after unconditionally accepting the tender conditions in its entirety, it is not permissible to put any remark(s) / condition(s) (except unconditional rebate on price, if any) in the ‘Price-Bid’ enclosed in “Envelope-2” and the same has been followed in the present case. In case this provision of the Tender is found violated at any time after opening “Envelope-2”, I / We agree that my/our tender shall be summarily rejected and EPI shall, without prejudice to any other right or remedy be at liberty to forfeit the full said Earnest Money absolutely.

3. The required Earnest Money for this work is enclosed herewith.

Yours faithfully,

(Signature of the Tenderer)

Seal of Tenderer

Dated : _____________________
FORM OF TENDER

To,

Engineering Projects (India) Limited
(Address of submission as mentioned in “Notice Inviting Tender”)

REF. : TENDER FOR (Name of Work as mentioned in “Notice Inviting Tender”)

NIT No. : _________________________________

1. I/We hereby tender for execution of work as mentioned in “Memorandum” to this “Form of Tender” as per Tender Documents within the time schedule of completion of work as per separately signed and accepted rates in the Bill of Quantities quoted by me/us for the whole work in accordance with the Notice Inviting Tender, Conditions of Contract, Specifications of materials and workmanship, Bill of Quantities Drawings, Time Schedule for completion of jobs, and other documents and papers, all as detailed in Tender Documents.

2. It is agreed that the time stipulated for jobs and completion of works in all respects and in different stages mentioned in the “Time Schedule for completion of jobs” and signed and accepted by me/us is the essence of the contract. I/We agree that in case of failure on my/our part to strictly observe the time of completion mentioned for jobs and the final completion of works in all respects according to the schedule set out in the said “Time Schedule for completion of jobs” and stipulations contained in the contract, the recovery shall be made from me/us as specified therein. In exceptional circumstances extension of time which shall always be in writing may, however be granted by EPI at its entire discretion for some items, and I/We agree that such extension of time will not be counted for the final completion of work as stipulated in the said “Time schedule of completion of jobs”.

3. I/We agree to pay the Earnest Money, Security Deposit cum Performance Guarantee, Retention Money and accept the terms and conditions as laid down in the “Memorandum” to this “Form of Tender”.

4. Should this Tender be accepted, I/We agree to abide by and fulfill all terms and conditions referred to above and as contained in Tender Documents elsewhere and in default thereof, allow EPI to forfeit and pay EPI, or its successors or its authorized nominees such sums of money as are stipulated in the Tender Documents.

5. I/We hereby pay the earnest money amount as mentioned in the “Memorandum” to this “Form of Tender” in favour of Engineering Projects (India) Limited payable at place as mentioned in the “NIT/ITT”.

Signature of Contractor

Page 8

EPI
6. If I/we fail to commence the work within 10 days of the date of issue of Letter of Intent and / or I/We fail to sign the agreement as per Clause 84 of General Conditions of Contract and/or I/We fail to submit Security Deposit cum Performance Guarantee as per Clause 9.0 & 9.1 of General Conditions of Contract, I/We agree that EPI shall, without prejudice to any other right or remedy, be at liberty to cancel the Letter of Intent and to forfeit the said earnest money as specified above.

7. I/We are also enclosing herewith the Letter of Undertaking on the prescribed pro-forma as referred to in condition of NIT.

Date the __________________________ day of _______________________________

SIGNATURE OF TENDERER

NAME (CAPITAL LETTERS) : _________________________________________

OCCUPATION _______________________________________

ADDRESS _______________________________________

_______________________________________

SEAL OF TENDERER
MEMORANDUM

(ENCLOSURE TO FORM OF TENDER)

REF. : TENDER FOR (Name of Work as mentioned in “Notice Inviting Tender”)

NIT No. : __________________________

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<td>Schedule of Rates applicable</td>
<td>69.0</td>
<td>Civil Works : __________________________ Sanitary Works : __________________________ Electrical Works : __________________________</td>
</tr>
<tr>
<td></td>
<td>Validity of Tender</td>
<td>4.0</td>
<td>90 (Ninety) Days</td>
</tr>
<tr>
<td></td>
<td>Security Deposit cum Performance Guarantee</td>
<td>9.0</td>
<td>5.00% (Five Percent only) of Contract Value within 10 days from the date of issue of telegram / letter / telex / FAX of Intent of acceptance of Tender.</td>
</tr>
</tbody>
</table>

Signature of Contractor
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Number</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>xiii)</td>
<td>Retention Money</td>
<td>10.0</td>
<td>5.00% (Five percent only) of the contract amount, which shall be deducted in the manner set out in this contract.</td>
</tr>
</tbody>
</table>
xiv)  | Time allowed for starting the work | 43.0   | The date of start of contract shall be reckoned 10 days from the date of issue of telegram / letter / telex / FAX of Intent of acceptance of Tender. |
xv)   | Defect Liability Period         | 74.0   | 12 (Twelve) Months from the date of taking over of works.               |
xvi)  | Arbitration                      | 76     | Arbitration shall be as per provisions of Clause no. 76 of GCC. The Venue of Arbitration shall be .................................. |
xvii) | Jurisdiction                     | 76.3   | Courts in -------------------------------                            |

SIGNATURE OF TENDERER

NAME (CAPITAL LETTERS) : _________________________________________

OCCUPATION : _________________________________________

ADDRESS : _________________________________________

_________________________________________

SEAL OF TENDERER
GENERAL CONDITIONS OF CONTRACT

AND

LABOUR SAFETY PROVISIONS, MODEL RULES
CONTRACTOR’S LABOUR REGULATIONS
& PRESCRIBED PROFORMAS
GENERAL CONDITIONS OF CONTRACT

1.0 GENERAL

The Contract means the documents forming the Tender and acceptance thereof and the formal agreement executed between the competent authority on behalf of EPI and the Contractor, together with the documents referred to therein including these conditions, the Specifications, Designs, Drawings and Instructions issued from time to time by the Engineer-In-Charge and all these documents taken together, shall be deemed to form one contract and shall be complementary to one another.

1.1 In the contract, the following expressions shall, unless the context otherwise requires, have the meanings, hereby respectively assigned to them.

1.2 Engineering Projects (India) Limited, hereinafter called ‘EPI’ proposes to get the works executed as mentioned in the Contract on behalf of Owner/Client.

1.3 The work will be executed as per Drawings “GOOD FOR CONSTRUCTION” to be released by EPI unless otherwise specified elsewhere in the Tender Documents.

1.4 OTHER DEFINITIONS

a) ENGINEER-IN-CHARGE means the Regional Office In-Charge of EPI himself or an engineer of EPI nominated by the Regional Office In-Charge for supervision and/or project management of the project from time to time.

b) WORKS OR WORK The expression works or work shall unless there be something either in the subject or context repugnant to such construction, be construed and taken to mean the works by or by virtue of the contract contracted to be executed whether temporary or permanent, and whether original, altered, substituted or additional.

c) CONTRACTOR The Contractor shall mean the individual, firm or company, whether incorporated or not, undertaking the works and shall include the legal personal representative of such individual or the persons composing such firm or company, or the successors of such firm or company and the permitted assignees of such individual, firm or company.

d) DRAWINGS mean the Drawings referred to in the Bill of Quantities, specifications and any modifications of such Drawings or such other Drawings as may from time to time be approved or furnished by EPI.

e) SITE means the lands and other places on, under, in or through which the works are to be executed or carried out and any other lands or places provided by EPI or used for the purpose of the agreement.

f) APPROVAL means approved in writing including subsequent written confirmation of previous verbal approval.
g) WRITING means any manuscript typed, written or printed statement under or over signature and/or seal as the case may be.

h) MONTH means English Calendar month. ‘Day’ means a Calendar day of 24 Hrs each.

i) CONTRACT VALUE means the sum for which the Tender is accepted as per the Agreement/ Letter of Acceptance/ Letter of Intent.

j) LANGUAGE: All documents and correspondence in respect of this contract shall be in English Language. In case of any discrepancy between the English version and the Hindi version of these documents, the provisions contained in the English version shall be applicable.

k) BILL OF QUANTITIES or SCHEDULE OF QUANTITIES means the priced and completed Bill of Quantities or Schedule of Quantities forming part of the Tender.

l) OWNER/ CLIENT / EMPLOYER means the Government, Organization, Authority, Company, Ministry, Department, Society, Cooperative etc. who has awarded the work/ project to EPI and/ or appointed EPI as Implementing / Executing Agency/ Project Manager and/ or for whom EPI is acting as an agent and on whose behalf EPI is entering into the contract and getting the work executed.

m) IMPLEMENTING/ EXECUTING AGENCY means EPI

n) TENDER means the Contractor's priced offer to EPI for the execution and completion of the work and the remedying of any defects therein in accordance with the provisions of the Contract, as accepted by the Letter of Intent or Award letter. The word TENDER is synonymous with Bid and the word TENDER DOCUMENTS with “Bidding Documents” or “offer documents”.

o) The headings in the clauses/ conditions of Tender Documents are for convenience only and shall not be used for interpretation of the clause/ condition.

p) Words imparting the singular meaning only also include the plurals and vice versa where the context requires. Words imparting persons or parties shall include firms and corporations and organizations having legal capacities.

q) APPROVED INSURANCE COMPANY means any Insurance Company registered with ‘Insurance Regulatory & Development Authority’ (IRDA) of India and meeting insurance needs of the projects of EPI.

2.0 SITE VISIT AND COLLECTING LOCAL INFORMATION

Before tendering, the tenderer is advised to visit the Site, its surroundings to assess and satisfy themselves about the local conditions such as the working and other constraints at Site, approach roads to the Site, availability of water & power supply, applicability of taxes, duties and levies etc., nature of ground, soil and sub-soil condition, underground water table level, accommodations they may
require etc., river regime, river water levels, other details of river, streams & any other relevant information required by them to execute the complete scope of work. The tenderer may obtain all necessary information as to risks, weather conditions, contingencies & other circumstances (insurgencies etc.) which may influence or affect their tender prices. Tenderer shall be deemed to have considered Site conditions whether he has inspected it or not and to have satisfied himself in all respects before quoting his rates and no claim or extra charges whatsoever in this regard shall be entertained / payable by EPI at a later date.

2.1  ACCESS BY ROAD

Contractor, if necessary, shall build temporary access roads to the actual Site of construction for the works at his own cost to make the Site accessible. The Contractor shall maintain the same in motorable condition at all times as directed by Engineer-In-Charge at his own cost. The Contractor shall be required to permit the use of any roads so constructed by him for vehicles of EPI or any other agencies/ Contractors who may be engaged on the project Site, free of cost.

Non-availability of access roads or approach to Site, for the use of the Contractor shall in no case condone any delay in the execution of work nor be the cause for any claim for compensation.

2.2  HANDING OVER & CLEARING OF SITE

2.2.1 The Contractor should note that area for construction may be made available in phases as per availability and in conjunction with pace of actual progress of work at Site. The work may be required to be carried out in constrained situations. The work is to be carried out in such a way that the traffic, people movement, if any, is kept operative and nothing extra shall be payable to the Contractor due to this phasing / sequencing of the work. The Contractor is required to arrange the resources to complete the entire project within total stipulated time. Traffic diversion, if required, is to be done and maintained as per specification by the Contractor at his own cost and the Contractor shall not be entitled for any extra payment, whatsoever, in this regard.

2.2.2 Efforts will be made by EPI to handover the Site to the Contractor free of encumbrances. However, in case of any delay in handing over of the Site to the Contractor, EPI shall only consider suitable extension of time for the execution of the work. It should be clearly understood that EPI shall not consider any revision in contract price or any other compensation whatsoever viz. towards idleness of Contractor’s labour, equipment etc.

2.2.3 The Contractor shall be responsible for removal of all over-ground and under-ground structures (permanent, semi-permanent and temporary) and constructions from the Site. The cost to be incurred in this regard shall be deemed to be included in the quoted rates of Bill of Quantities items and Contractor shall not be entitled for any extra payment whatsoever, in this regard. Old structures on the proposed Site, if required, shall be demolished by the Contractor properly. The useful material obtained from demolition of structures &
services shall be the property of the Owner/EPI and these materials shall be stacked in workmanship like manner at the place specified by the Engineer-in-charge.

2.2.4 If required, the Contractor has to do site clearance, enabling work, barricading, diversion of Roads, shifting/ realignment of existing utility services, drains, nallahs etc. at his own cost as per direction of Engineer-In-Charge and the Contractor shall not be entitled for any extra payment whatsoever in this regard.

2.2.5 Necessary arrangements including its maintenance are to be made by the Contractor for temporary diversion of flow of existing drain and road, as the case may be. The existing drain, road would be demolished, wherever required, with the progress of work under the scope of proposed project. The existing Road and Drain, which are not in the alignment of the said project but are affected and/ or need to be demolished during execution for smooth progress of the project, shall be restored to its original status and condition (including black topping) by the Contractor at his own. The cost to be incurred by Contractor in these regards shall be deemed to be included in the quoted rates of the Bill of Quantities items and Contractor shall not be entitled for any extra payment whatsoever, in these regards.

2.2.6 The Contractor shall be responsible to co-ordinate with service provider/ concerned authorities for cutting of trees, shifting of utilities and removal of encroachments etc. and making the Site unhindered for completion of work. This shall include initial and frequent follow up meetings/ actions/ discussions with each involved service provider/ concerned authorities. The Contractor shall not be entitled for any additional compensation for delay in cutting of trees, shifting of utilities and removal of encroachments by the service provider/ concerned authorities.

2.2.7 The information about the public utilities (whether over ground or underground) like electrical/ telephone/ water supply lines, OFC Cables, sewer lines, open drains etc. is the responsibility of Contractor who has to ascertain the utilities that are to be affected by the works through the site investigation and collection of information from the concerned utility Owners.

2.2.8 The Contractor shall be responsible to obtain necessary approval from the respective authorities for shifting/ re-alignment of existing public utilities. EPI shall only provide necessary letters required for liaisoning by the Contractor in obtaining the approval from the concerned authorities.

2.2.9 Any services affected by the works must be temporarily supported by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of works. It shall be deemed to be the part of the contract and no extra payment shall be made to the Contractor for the same. Shifting/ re-alignment of public utilities should be done without disturbing the existing one. New service lines should be laid and connected before dismantling the existing one.

2.2.10 Shifting/ re-alignment of existing public utilities shall be done by the Contractor as per technical requirement of respective bodies or as per direction of Engineer-In-Charge. Shifting/ re-alignment of public utilities includes all materials, labours,
tools and plants and any other expenses whatsoever for the same. The cost to be incurred in this regard shall be deemed to be included in his quoted rates of BOQ items and the Contractor shall not be entitled for any extra payment, whatsoever, in this regard. In case any of these services are shifted by the State Govt/local authorities themselves for which deposit as per their estimates is to be made to them, the Contractor shall deposit the same and the Contractor shall be paid only at the rates quoted by him in BOQ for quantity specified in the BOQ, if such items are included in the BOQ irrespective of amount paid by him to the State Govt/local authorities for execution of these works. In case such provision is not made in the BOQ or the quantity exceeds those specified in the BOQ, the same is deemed to be included in the rates quoted by him for other items in BOQ and nothing extra shall be payable to Contractor on this account.

3.0 SCOPE OF WORK

3.1 The scope of work covered in this Tender shall be as per the Bill of Quantities, Specifications, Drawings, Instructions, Orders issued to the Contractor from time to time during the pendency of work. The Drawings for this work, which may be referred for tendering, provide general idea only about the work to be performed under the scope of this contract. These may not be the final drawings and may not indicate the full range of the work under the scope of this contract. The work will be executed according to the Drawings to be released as “GOOD FOR CONSTRUCTION” from time to time by the Engineer-In-Charge of EPI and according to any additions/modifications/alterations/deletions made from time to time, as required by any other drawings that would be issued to the Contractor progressively during execution of work. It shall be the responsibility of the Contractor to incorporate the changes that may be in the scope of work, envisaged at the time of tendering and as actually required to be executed.

3.2 The quantities of various items as entered in the “BILL OF QUANTITIES” are indicative only and may vary depending upon the actual requirement. The Contractor shall be bound to carry out and complete the stipulated work irrespective of the variation in individual items specified in the Bill of Quantities. The variation of quantities will be governed as per clause No.69 of GCC.

4.0 VALIDITY OF TENDER

The Tender for the works shall remain open for acceptance for a period of ninety days from the date of opening of Price Bid of Tenders. The earnest money will be forfeited without any prejudice to any right or remedy, in case the Contractor withdraws his Tender during the validity period or in case he changes his offer to his benefits, which are not acceptable to EPI. The validity period may be extended on mutual consent.

5.0 ACCEPTANCE OF TENDER

EPI reserves to itself the authority to reject any or all the Tenders received without assigning any reason. The acceptance of a Tender shall be effective w.e.f. the date on which the telegram/letter of intent or acceptance of the Tender is put in the communication by EPI. EPI also reserves the right to split the work
among two or more parties at lowest negotiated rate without assigning any reason thereof. The Contractor is bound to accept the portion of work as offered by EPI after split up at the quoted/ negotiated rates.

6.0 SET OF TENDER DOCUMENTS:

The following documents will complete a set of Tender Documents.

A) VOLUME I:
   a) Instructions to tenderers
   b) General Conditions of Contract

B) VOLUME II:
   a) Notice Inviting Tenders
   b) Additional Conditions of Contract
   c) Technical Specifications (General, Additional & Technical specifications)
   d) Tender Drawings

C) VOLUME III:
   a) Schedule of Rates/ Bills of quantities (Price-Bid)

7.0 EARNEST MONEY DEPOSIT

Earnest Money Deposit (EMD) of amount as mentioned in “Memorandum” to “Form of Tender” required to be submitted along with the Tender shall be in the form of Demand Draft payable at place as mentioned in “Notice Inviting Tender”/ “Instructions to Tenderers” in favour of ‘Engineering Projects (India) Limited’ from any Nationalised bank / Scheduled Bank or in the form of Bank Guarantee from any Nationalised bank / Scheduled Bank as per the enclosed format. The EMD shall be valid for minimum period of 150 days (One hundred fifty Days) from last day of submission of Tender.

7.1 EMD shall accompany the offer and placed in the sealed envelope cover of the offer as detailed in Instructions to Tenderer. Any tender not accompanied with the requisite Earnest Money Deposit alongwith ‘Letter of Undertaking’ shall be rejected and such tenderer(s) will not be allowed to attend the opening of bids.

7.2 The EMD of all unsuccessful tenderers (i.e. except evaluated lowest tenderer) shall be returned within Seven (7) days of the opening of price bids by EPI. Subject to clause 7.6 herein below, EMD of successful tenderer shall be refunded after submission of Security Deposit cum Performance Guarantee by him.

7.3 Once the tenderer has given an unconditional acceptance to the tender conditions in its entirety, he is not permitted to put any remark(s)/condition(s) (except unconditional rebate on price, if any) in/ along-with the Tender.

7.4 In case the condition 7.3 mentioned above is found violated at any time after opening of Tender, the Tender shall be summarily rejected and EPI shall, without
prejudice to any other right or remedy, be at liberty to forfeit the full said Earnest Money absolutely.

7.5 No interest will be payable by EPI on the said amount covered under EMD/Other security documents.

7.6 EMD of successful tenderer, if deposited in the form of Demand Draft, shall be treated as part of Retention Money.

7.7 At any time after the due date of the Tender, if any tenderer alters /modifies/withdraws his tender within the validity period (or the extended validity period) of his tender or fails to furnish the “Security Deposit cum Performance Guarantee” or the “Additional Performance Guarantee” or fails to execute the “Contract Agreement” within the prescribed time period after the placement of LOI on him, EPI without prejudice to any other rights or remedies shall be at liberty to forfeit the Earnest Money deposited by the tenderer. In the event of re-tender, such tenderer shall not be allowed to submit tender

8.0 MOBILIZATION ADVANCE

8.1 Mobilization advance up to maximum of amount as mentioned in the “Memorandum” to the “Form of Tender” shall be paid to the Contractor on submission of non-revocable and unconditional Bank Guarantee of an equivalent amount in case of interest free Mobilization Advance or for an amount equal to 110% of the Mobilization Advance in case of interest bearing Mobilization Advance, from a Nationalized Bank / Scheduled Bank as per the enclosed Performa subject to conditions given hereunder. The Mobilization Advance shall be at the Interest Rate as mentioned in the “Memorandum” to the “Form of Tender”. This advance shall be paid in three installments as follows:

i) First Installment of fifty percent of total mobilization advance shall be paid after fulfillment of the following conditions:

   a) Signing of the agreement.
   b) Submission of Security Deposit cum Performance Guarantee as per Clause No. 9.

ii) Second installment of twenty five percent of total mobilization advance will be paid after the setting up of site office and providing facilities to EPI as per contract, and completion of enabling works required for taking up the construction. These include construction of store, labour hutments, etc.

iii) The balance twenty five percent of total mobilization advance shall be paid on mobilization of manpower, plant & equipment etc. to the satisfaction of Engineer-In-Charge of EPI.

8.2 The Advance shall be recovered on monthly installment basis. The installments shall commence when 20% of the scheduled contract period has elapsed and fully recovered when 80% of the scheduled contract period is over, both from
date of start. (The month of start & completion of recovery of mobilization advance to be rounded off to nearest full month).

8.3 Part ‘Bank Guarantees’ (BGs) against mobilization advance shall be furnished in as many numbers as the number of recovery installments as given in “Memorandum” to the “Form of Tender” and should be equivalent to the amount of each recovery installment. At any point of time, if the Contractor's payable amount on account of work done is not available with EPI or the amount payable is less than the recovery installment, recovery of such advance shall be effected by encashing the BG of equivalent recovery amount. The decision of EPI in this regard shall be final and binding on the Contractor. The validity period for the part BGs shall be till three months after the end of the month in which instalment is due to be recovered with further three months claim period.

8.4 In case recovery of Mobilization Advance is delayed, interest shall be charged @12% (Twelve percent) per annum on delayed recoveries due to late submission of bills by the Contractor or due to delayed encashment of Bank Guarantee, as stated above or due to any other reasons whatsoever.

8.5 Contractor is required to furnish the Utilization Certificate for each installment of mobilization advance to the satisfaction of Engineer-In-Charge. Subsequent installments of mobilization advance shall be released only after getting satisfactory utilisation certificate from the Contractor for the earlier released installment.

8.6 Notwithstanding what is contained in aforesaid clauses, no mobilization advance whatsoever shall be payable, if payment of mobilization advance is not mentioned in the “Memorandum” to the “Form of Tender”.

9.0 SECURITY DEPOSIT CUM PERFORMANCE GUARANTEE

“Within 10 (ten) days from the date of issue of letter of Intent or within such extended time as may be granted by EPI in writing, the Contractor shall submit to EPI a Security Deposit cum Performance Bank Guarantee in the form appended, from any Nationalised bank / Scheduled Bank equivalent to 5% (five percent only) of the Contract Value for the due and proper execution of the contract. This bank guarantee shall remain valid up to 90 (ninety) days after the end of defects liability period.

In case the Contractor fails to submit the Security Deposit cum Performance Guarantee of the requisite amount within the stipulated period or extended period, letter of intent will stand withdrawn and EMD of Contractor shall be forfeited.

9.1 ADDITIONAL PERFORMANCE GUARANTEE FOR EXISTING CONTRACTORS

In case bidder is a working Contractor of EPI at the time of issuance of Letter of Intent (LOI) for the work, the bidder has to furnish an additional Performance Guarantee of 1% (One Percent) of the Contract Value of the work, in case working capacity of the bidder is less than the aggregate of balance work-load of all the works of the bidder with EPI as on date of placement of LOI for this work. The balance workload shall also include the value of work awarded but not yet
started and finally approved value of this work. This additional Performance Guarantee shall be in addition to the Security Deposit cum Performance Guarantee of the works to be furnished by the bidder as specified in the clause no. 9 of General Conditions of Contract. Further, no relaxation in Security Deposit cum Performance Guarantee as in clause no. 9 of General Conditions of Contract shall be made in case working capacity works-out to be more than the balance value of works as mentioned above. The working capacity of the Contractor shall be calculated as under:

\[
\text{WORKING CAPACITY} = 2.5 \times (\text{Average Turnover of the party as per latest three audited Balance Sheets}).
\]

NOTE: The decision of amount of additional Performance Guarantee as above shall be taken by EPI and shall be final & binding to the Contractor.

In case the Contractor fails to submit the additional performance guarantee of the requisite amount within 10 days from the date of issue of letter of Intent or within such extended time as may be granted by EPI in writing, the letter of intent will stand withdrawn and EMD of the Contractor shall be forfeited.

9.2 ABNORMALLY HIGH AND LOW RATED ITEMS

For item rate tenders if, the rates quoted by the lowest bidder for certain items of the Bill of Quantities of the Tender are found to be abnormally high or low in comparison to the Market Rate analysis of the item done by EPI and/or in comparison to EPI's method of working out market rate justification for the items, the same shall be governed as under:

For Abnormally High Rated items (AHR), the progressive payment shall be 80% (Eighty percent) of the payment due to the Contractor against execution of the AHR items. The balance withheld 20% (twenty percent) payment shall be released after 80% of total value of the original contract is completed in financial terms in order to ensure that the Abnormally Low Rated (ALR) items identified at the time of Award of work have been executed as per requirement of project and as per terms of Contract. Further, deviation limit for AHR items shall be nil on plus side and 100% on minus side. The provision of deviation limit of clause 69.1(v) shall not apply to AHR items. In case of deviation of quantities given in schedule of quantities for AHR items on plus side, the same shall be governed by clause 69.2. The decision of Engineer-In-Charge of EPI in this regard shall be final and binding on the Contractor.

The provision of para 9.2 shall not be applicable on tenders invited on Percentage Rate/lump Sum basis.
The decision of EPI on identification/marking of AHR and ALR items is final and binding on the Contractor. In case the Contractor does not agree to the identified AHR and ALR items, at the time of award of works, the EMD/Security Deposit cum Performance Guarantee of the Contractor shall be forfeited and decision of EPI in this regard shall be final & binding on the Contractor.

10.0 RETENTION MONEY

The Retention Money shall be deducted from each running bill of the Contractor at 5% (five percent only) of the gross value of the Running Account bill. The Earnest Money Deposited by the tenderer in the form of Demand Draft will be treated as part of the Retention Money. The Retention Money shall be refunded to the Contractor after expiry of defects liability period (referred to in Clause No. 74) or on payment of the amount of the final bill whichever is later. If the amount of Retention Money deduction in cash is more than Rs.10.00 lakhs (Rupees Ten lakhs only), the excess amount can be refunded to Contractor against submission of Bank Guarantee of equivalent amount from a Nationalised bank / Scheduled Bank in the prescribed proforma of Performance Guarantee of EPI.

11.0 MOBILIZATION OF MEN, MATERIALS AND MACHINERY:

11.1 All expenses towards mobilization at Site and de-mobilization including bringing in equipment, work force, materials, dismantling the equipments, clearing the Site etc. shall be deemed to be included in prices quoted and no separate payment on account of such expenses shall be entertained.

11.2 It shall be entirely the Contractor’s responsibility to provide, operate and maintain all necessary construction equipments, scaffoldings and safety gadget, lifting tackles, tools and appliances to perform the work in a workman like and efficient manner and complete all jobs as per the specifications and within the schedule time of completion of work. Further, Contractor shall also be responsible for obtaining temporary electric and water connection for all purposes. The Contractor shall also make standby arrangement for water & electricity to ensure un-interrupted supply.

11.3 It shall be the responsibility of the Contractor to obtain the approval for any revision and/ or modification desired by him from EPI before implementation. Also such revisions and/or modifications if accepted / approved by EPI shall be carried at no extra cost to EPI.

11.4 The procurement and supply in sequence and at the appropriate time of all materials and consumable shall be entirely the Contractor’s responsibility and his rates for execution of work shall be inclusive of supply of all these items.
11.5 It is mandatory for the Contractor to provide safety equipments and gadgets to its all workers, supervisory and Technical staff engaged in the execution of the work while working. The minimum requirement (but not limited to) shall be gumboots, safety helmets, Rubber hand gloves, facemasks, safety nets, belts, goggles etc. as per work requirements. Sufficient nos. of these equipments and gadgets shall also be provided to EPI by the Contractor at his own cost for use of EPI Officials and/ or workforce while working/ supervision at Site. No staff/ worker shall be allowed to enter the Site without these equipments/ gadgets. The cost of the above equipments/ gadgets are deemed to be included in the rates quoted by the Contractor for the items & works as per Bill of Quantities and Contractor shall not be entitled for any extra cost in these regard. The above norm is to be strictly complied with at Site. In case the Contractor is found to be deficient in providing Safety Equipments/ Gadgets in the opinion of Engineer-In-Charge, the Engineer-In-Charge at his option can procure the same at the risk & cost of Contractor and provide the same for the use of worksite and shall make the recoveries from the bills of the Contractor for the same. The decision of the Engineer-In-Charge shall be final and binding on Contractor in this regard.

11.6 All Designs, Drawings, Bill of Quantities, etc. (except Bar Bending Schedule, Shop & Fabrication Drawings) for all works shall be supplied to the Contractor for all buildings services and development works by EPI in phased manner as the works progress. However it shall be the duty and responsibility of the Contractor to bring to the notice of EPI in writing as to any variation, discrepancy or any other changes required and to obtain revised drawings and designs and / or approval of EPI in writing for the same.

11.7 One copy of contract documents including Drawings furnished to the Contractor shall be kept at the Site and the same shall at all reasonable times be available for inspection.

11.8 All materials, construction plants and equipments etc. once brought by the Contractor within the project area, will not be allowed to be removed from the premises without the written permission of EPI. Similarly all enabling works built by the Contractor for the main construction undertaken by him, shall not be dismantled and removed without the written authority of EPI.

11.9 Contractor shall have to prepare the Bar Bending Schedule, Shop and Fabrication Drawings free of cost, if required for any of the items of work. Five copies of these Drawings each including for revision will be submitted to EPI for approval. Before executing the item, Bar Bending Schedule, Shop & Fabrication Drawings should be got approved from EPI.

12.0 **INCOME TAX DEDUCTION**

Income tax deductions shall be made from all payments made to the Contractor including advances against work done, in accordance with the Income Tax act prevailing from time to time.
13.0  TAXES AND DUTIES

13.1  The Contractor shall be responsible for the payment, wherever payable, at his own cost of all taxes such as excise duty, custom duty, sales tax, including the purchase tax, consignment tax, work contract tax, service tax, VAT or any other similar tax in the state concerned, turnover tax, toll tax, octroi charges, royalty, cess, levy and other tax (es) or duty (ies) which may be specified by local/ state/ central government from time to time on all materials, articles which may be used for this work. The rates quoted by him in the Tender in Bill of Quantities shall be inclusive of all such taxes, duties, etc. The imposition of any new and/ or increase in the aforesaid taxes, duties, levies (including fresh imposition of Work Contract Tax, Turnover Tax, Sales Tax on Work Contract, VAT or any other similar Tax) etc. during the currency of the contract shall be borne by Contractor and shall not be paid or reimbursed to the Contractor by EPI. In the event of non-payment/default in payment of any octroi, royalty, cess, turnover tax, sales tax, including the purchase tax, consignment tax, work contract tax, VAT, Service Tax or any other similar tax in the state concerned, customs, excise or any other levy/tax including labour dues etc. by Contractor, EPI reserves the right to withhold the dues/ payments of Contractor and make payment to local/state/ Central Government authorities or to labourers as may be applicable. The Contractor should submit along with the Tender Registration Certificates with Sales Tax on works contract authority etc. otherwise appropriate recovery shall be made from his bills.

13.2  The rate quoted by the Contractor shall be deemed to be inclusive of all Taxes and duties as mentioned in clause no.13.1 given above or any other tax as applicable and the same shall not be reimbursed by EPI. Tax deductions at source shall be made as per laws prevalent in the State.

13.3  The stamp duty and registration charges, if any, on the contract agreement levied by the Government or any other statutory body, shall be paid by the Contractor.

13.4  It will be incumbent upon the Contractor to obtain a registration certificate as a dealer under the Local Sales Tax Act and the Central Sales Tax Act, Service Tax, etc. and necessary evidence to this effect shall be furnished by the Contractor to EPI. Sales Tax on the transactions between the Contractor and his Sub-Contractor/Vendors etc. shall be borne by the Contractor. The Contractor shall be responsible for any taxes that may be levied hereunder on the transaction between Contractor and EPI.

13.5  The bidder shall quote his rates inclusive of Turnover Tax/ Sales Tax on Works Contract payable to State Govt. along-with other taxes, duties, levies etc. in conjunction with other terms and conditions. In case, the Turnover Tax/ Sales Tax on Works Contract on execution of works is waived off by the State Govt. at later stage for this project, the equivalent amount from the date of waiver of such tax (as per prevailing rate as on the date of waiver of Turnover Tax/ Sales Tax on Works Contract) shall be deducted from the amount payable to the Contractor from subsequent RA Bills.
13.6 VALUE ADDED TAX (VAT)

The consideration agreed for the execution of said contract shall include the taxes, duties, cess, etc. such as excise duty, service tax, VAT, which is leviable or may be levied in future under any State Law or the Central Law on execution of said contract, such taxes shall be borne by the Contractor and shall not be reimbursed by EPI. Further, if due to any variance in such tax, duties, cess etc. there is any increase in the taxes, the same shall also be borne by the Contractor. Where under any of the State or the Central Law, there is requirement of deduction of tax at source, the same shall be deducted from the amount paid or payable to the Contractor pursuant to this contract and shall be deposited to the Government authorities by EPI. EPI shall issue the documents/forms/certificate as prescribed under the relevant law, in respect of the amount so deducted from the amount paid or payable to the Contractor. EPI shall have full rights to withhold the amount payable to the Contractor in pursuant to this contract, if Contractor does not fulfill his obligation under any State or Central Law relating to execution of said contract, in case the amount has already been paid by EPI, EPI has the right to recover such payments from the Contractor.

14.0 ROYALTY ON MATERIALS:

The Contractor shall deposit royalty and obtain necessary permit for supply of bajri, stone, kankar, sand, etc. from the local authorities and quoted rates shall be inclusive of royalty.

15.0 RATES TO BE FIRM

15.1 The rates quoted by the tenderer shall be firm and fixed for the entire period of completion and till handing over of the work. No revision to rates or any escalation shall be allowed on account of any increase in prices of materials, labour, POL and Overheads etc or any other statutory increase during the entire contract period or extended contract period.

15.2 The Contractor shall be deemed to have inspected the Site, its surrounding and acquainted itself with the nature of the ground, accessibility of the Site and full extent and nature of all operations necessary for the full and proper execution of the contract, space for storage of materials, construction plant, temporary works, restrictions of working time, restrictions on the plying of heavy vehicles in area, supply and use of labour, materials, plant, equipment and laws, rules and regulations, if any, imposed by the local authorities.

15.3 The rates and prices to be tendered in the Bill of Quantities are for completed and finished items of works complete in all respects. It will be deemed to include all construction plant, labour, supervision, materials, transport, all temporary works, erection, maintenance, Contractor’s profit and establishment/overheads, together with preparation of designs & drawings pertaining to casting yard, shop drawing, fabrication drawing (if required), staging form work, stacking yard, etc. all general risk, taxes, royalty, duties, cess, octroi and other levies, insurance,
liabilities and obligations set out or implied in the Tender Documents and contract.

15.4 Unless otherwise specified in the Bill of Quantities (BOQ), the Contractor has to make his own arrangement for dewatering/bailing out of water, effluent including strutting, shoring etc at every stage of work wherever required (including Tunnel work) including working under foul condition as per direction of Engineer-In-Charge at his own cost and the Contractor shall not be entitled for any extra payment, whatsoever, in this regard.

15.5 If required to make work site suitable for execution, Contractor shall have to clear jungle including of rank vegetation, grass, trees etc., clear & clean existing drains/canals (including strutting, shoring and packing cavities) and dispose them out of the Site up-to any lead and lift as per direction of Engineer-In-Charge. The Contractor should inspect the Site of work from this point of view. Unless otherwise specified in the Bill of Quantities, the cost to be incurred in this regard shall be deemed to be included in his quoted rates of BOQ items and the Contractor shall not be entitled for any extra payment in this regard.

15.6 If any temporary/permanent structure is encountered or safety of such structure in the vicinity is endangered due to execution of the project, the Contractor has to protect the structures by any means as per direction of Engineer-in-Charge. If any damage caused to any temporary or permanent structure(s) in the vicinity is caused due to execution of the project, the Contractor has to make good the same by any means as per direction of Engineer-in-Charge. The Contractor should inspect the Site of work from this point of view. The cost to be incurred in this regard shall be deemed to be included in his quoted rates of BOQ items and the Contractor shall not be entitled for any extra payment in this regard.

16.0 ESCALATION / PRICE VARIATION

No claim on account of any Price Variation/Escalation on whatsoever ground shall be entertained at any stage of works. All rates as per Bill of Quantities (BOQ)/Price-Bid quoted by Contractor shall be firm and fixed for entire contract period as well as extended period for completion of the works. No escalation/price variation clause shall be applicable on this contract.

17.0 INSURANCE OF WORKS ETC.

Contractor is required to take Contractor’s All Risk Policy or Erection All Risk Policy (as the case may be) including Marine Insurance from an Approved Insurance Company in the joint name with EPI and bear all costs towards the same for the full period of execution of works including the defect liability period for the full amount of contract against all loss or damage from whatever cause arising for which he is responsible under the terms of the contract and in such manner that EPI and the Contractor are covered during the period of construction of works and/or also covered during the period of defect liability for the loss or damage as under:

a. The work and the temporary works to the full value of such works.
b. The materials, construction plant, centering, shuttering and scaffolding materials and other things brought to the Site for their full value. Whenever required by EPI, the Contractor shall produce the policy or the policies of insurance and the receipts for payment of the current premiums.

18.0 **INSURANCE UNDER WORKMEN’S COMPENSATION ACT**

Contractor is required to take insurance cover as per requirement of the Workmen’s Compensation Act, 1923 amended from time to time from an Approved Insurance Company and pay premium charges thereof. Wherever required by EPI the Contractor shall produce the policy or the policies of Insurance and the receipt of payment of the current premiums.

19.0 **THIRD PARTY INSURANCE**

Contractor is required to take third party insurance cover for an amount of 5% (five percent) of Contract Value from an Approved Insurance Company for insurance against any damage, injury or loss which may occur to any person or property including that of EPI, arising out of the execution of the works or temporary works. Wherever required by EPI the Contractor shall produce the policy or the policies of Insurance and the receipt of payment of the current premiums.

In case of failure of the Contractor to obtain insurance for works, insurance under Workman Compensation Act and Third Party insurance as described above within one month from the date of commencement of work, running account payments of the Contractor shall be withheld till such time the aforesaid insurance covers are obtained by the Contractor.

20.0 **INDEMNITY AGAINST PATENT RIGHTS**

The Contractor shall fully indemnify EPI from and against all claims and proceedings for or on account of any infringement of any patent rights, design, trademark or name or other protected rights in respect of any construction plant, machine, work or material used for in connection with the works or temporary works.

21.0 **LABOUR LAWS TO BE COMPLIED WITH BY THE CONTRACTOR**

The Contractor shall obtain a valid licence under the contract labour (Regulation & Abolition) Act 1970 and the Contract Labour Act (R&A) Central Rules 1971 and amended from time to time, and continue to have a valid licence until the completion of the work including defect liability period. The Contractor shall also abide by the provision of the child labour (Prohibition and Regulation) Act. 1986 and as amended from time to time. Any failure to fulfill this requirement shall attract the penal provisions of this contract arising out of the resultant non-execution of the work.
The Contractor shall comply with the provisions of the payment of Wages Act, 1936, Minimum Wages Act, 1948, Employer's Liability Act, 1938, Workmen's Compensation Act, 1923, Maternity Benefit Act, 1961 and Mines Act -1932, Industrial Disputes Act, 1947 or any modifications thereof or any other law relating thereto and rules made there under from, time to time.

21.1 No labour below the age of 18 years shall be employed on the work.

22.0 LABOUR SAFETY PROVISION

The Contractor shall be fully responsible to observe the labour safety provisions.

23.0 OBSERVANCE OF LABOUR LAWS

23.1 The Contractor shall be fully responsible for observance of all labour laws applicable including local laws and other laws applicable in this matter and shall Indemnify and keep indemnified EPI against effect of non observance of any such laws. The Contractor shall be liable to make payment to all its employees, workers and sub-Contractors and make compliance with labour laws. If EPI or the Client/ Owner/ Employer is held liable as "Principal Employer" to pay any amount or contributions etc. under legislation of Govt. or Court decision in respect of the employees of the Contractor, then the Contractor would reimburse the amount of such payments, contribution etc. to EPI and/ or same shall be deducted from the payments, Retention Money etc. of the Contractor.

23.2 The Contractor shall submit proof of having valid EPF registration certificate. In absence of the said certificate payment to the extent of 4.70% (four point seven percent) of the value of all the Running Account bills may be withheld by EPI and shall be released only after the production of the EPF registration certificate from the concerned authorities. If it is incumbent upon EPI to deposit withheld amount with EPF authorities, the withheld amount shall be deposited by EPI with EPF authorities. In such a case EPI shall not refund this withheld amount to the Contractor even after the production of EPF registration certificate.

23.3 The Contractor shall be liable to pay cess levied under the Building and other Construction Workers Welfare Cess Act, 1996, at such rates as may be notified by the Government from time to time. EPI shall deduct at source from every Running Account Bill of the Contractor, the said cess, at such rates for the time being prevailing, which shall not exceed 2% (two percent) but not be less than 1% (one percent) of the cost of construction incurred by EPI.

24.0 LAWS GOVERNING THE CONTRACT

This contract shall be governed by the Indian Laws for the time being in force and amended from time to time.

25.0 LAWS, BYE LAWS RELATING TO THE WORK

The Contractor shall strictly abide by the provisions, for the time being in force, of law relating to works or any regulations and bye laws made by any local authority or any water & lighting agencies or any undertakings within the limits of the
jurisdiction of which the work is proposed to be executed. The Contractor shall be bound to give to the authorities concerned such notices and take all approvals as may be provided in the law, regulations or bye laws as aforesaid, and to pay all fees and taxes payable to such authorities in respect thereof.

26.0 EMPLOYMENT OF PERSONNEL

26.1 The Contractor shall employ only Indian Nationals as his representatives, servants and workmen after verifying their antecedents and loyalty. He shall ensure that no personnel of doubtful antecedents & integrity and any other nationality in any way are associated with the works.

26.2 EPI shall have full power to get removed immediately any representative, agent, servant and workmen or employees of the Contractor on account of misconduct, negligence or incompetence or whose continued employment may in the opinion of the Engineer-In-Charge be undesirable without assigning any reason for the removal. The Contractor shall not be allowed any compensation on this account whatsoever.

27.0 TECHNICAL STAFF FOR WORK

27.1 The Contractor shall employ at his cost the adequate number of technical staff during the execution of this work depending upon the requirement of work. For this purpose the numbers to be deployed, their qualification, experience as decided by EPI shall be final and binding on Contractor. The Contractor shall not be entitled for any extra payment in this regard. The technical staff should be available at Site, whenever required by EPI to take instructions.

27.2 Within 15 days from the date of letter of intent, the Contractor shall submit a site organizational chart and Resume including details of experience of the Project-in-Charge and other staff proposed by him and shall depute them on the Project after getting approval from Engineer-In-Charge. If desired by the Contractor at later date, the Project-in-Charge and other staff whose resume is approved by EPI can be replaced with prior written approval of EPI and replacement shall be with equivalent or superior candidate only. Decision of Engineer-In-Charge shall be final and binding on the Contractor.

Even after approving the site organizational chart, the Engineer-In-Charge due to nature and exigency of work can direct the Contractor to depute such additional staff as in view of Engineer-In-Charge is necessary and having qualification and experience as approved by the Engineer-In-Charge. The removal of such additional staff from the Site shall only be with the prior written approval of Engineer-In-Charge. The Contractor shall not be paid anything extra whatsoever on account of deployment of additional staff and decision of the Engineer-In-Charge shall be final and binding on the Contractor.

27.3 In case the Contractor fails to employ the staff as aforesaid, he shall be liable to pay a reasonable amount not exceeding a sum of Rs. 25,000 (Rupees Twenty Five Thousand only) for each month of default in the case of each person. The
decision of the Engineer-In-Charge as to number of Technical Staff to be adequate for the project and the period for which the required technical staff was not employed by the Contractor and as to the reasonableness of the amount to be deducted on this account shall be final and binding on the Contractor.

28.0 LAND FOR LABOUR HUTS/ SITE OFFICE AND STORAGE ACCOMMODATION

28.1 The Contractor shall arrange the land for temporary office, storage accommodation and labour huts at his own cost and get the clearance of local authorities for setting up of labour camp and cost of same is deemed to be included in the rates quoted by the Contractor for the works. The Contractor shall ensure that the area of labour huts is kept clean and sanitary conditions are maintained as laid down by the local authorities controlling the area. The labour huts shall be so placed that it does not hinder the progress of work or access to the worksite. The vacant possession of the land used, for the purpose shall be given back by Contractor after completion of the work. The Retention Money of the Contractor shall be released only after Contractor demolishes all structures including foundations and gives back clear vacant possession of this land.

28.2 In the event the Contractor has to shift his labour camp at any time during execution of the work on the Instructions of local authorities or as per the requirement of the work progress or as may be required by EPI, he shall comply with such instructions at his cost and no claim whatsoever shall be entertained on this account.

28.3 FURNISHED OFFICE ACCOMMODATION & MOBILITY AND COMMUNICATION TO BE PROVIDED BY CONTRACTOR TO EPI

On acceptance of Tender, the Contractor at his own cost will construct a suitable furnished office at Site equipped with basic facilities such as telephone(s), fax, internet, photocopier, computer(s) & printer(s) along with operator(s), regular electricity & drinking water supply and vehicles for staff etc. as per the requirement of the project. The Contractor shall provide consumable as required and maintain the aforesaid facilities intact/operational during the currency of the contract including the defects liability period. The Contractor shall also make sufficient arrangement for photography/ videography preferably by maintaining a camera/video camera at Site so that photographs video can be taken of any specific activity at any point of time. The Contractor shall also provide software like MS Project etc. for the purpose of preparing progress report, etc.

28.4 The Contractor shall make all arrangements for ground breaking ceremony/ inaugural function etc for the project as required and the cost towards it is deemed to be included in his rates/offer. Any expenditure already incurred/to be incurred by EPI, shall be recovered from the Contractor.

28.5 PROTECTION OF TREES

Trees designated by the Engineer-In-Charge shall be protected from damage during the course of the works and earth level within one meter of each such tree shall not
be changed. Where necessary, such trees shall be protected by providing temporary fencing.

29.0 WATCH & WARD AND LIGHTING

The Contractor shall at his own cost take all precautions to ensure safety of life and property by providing necessary barriers, lights, watchmen etc. during the progress of work as directed by Engineer-In-Charge.

30.0 HEALTH & SANITARY ARRANGEMENTS

In case of all labour directly or indirectly employed in work for the performance on the Contractor’s part of this contract, the Contractor shall comply with all rules and regulations framed by Govt. from time to time for the protection of health and sanitary arrangements for workers.

31.0 WORKMEN’S COMPENSATION ACT

The Contractor shall at all times indemnify EPI and Owner against all claims for compensation under the provision of Workmen’s Compensation Act,1923 or any other law in force, for any workmen employed by the Contractor or his sub-Contractor in carrying out the contract and against all costs and expenses incurred by EPI therewith.

32.0 MINIMUM WAGES ACT

The Contractor shall comply with all the provisions of the Minimum Wages Act, 1948, Contract Labour Act (R&A) 1970, and rules framed thereunder and other labour laws/local laws affecting contract labour that may be brought into force from time to time.

33.0 LABOUR RECORDS

The Contractor shall submit by the 4th & 19th of every month to the Engineer-In-Charge of EPI a true statement, showing in respect of the second half of the preceding month and the first half of the current month, respectively, of the following data :-

a) The number of the labour employed by him (category-wise).

b) Their working hours.

c) The wages paid to them.

d) The accidents that occurred during the said fortnight showing the circumstances under which they happened and the extent of damage and injury caused.
e) The number of female workers who have been allowed Maternity Benefits under the Maternity Benefit Act, 1962 and the amount paid to them.

f) Any other information required by Engineer-In-Charge.

### 34.0 RELEASE OF RETENTION MONEY AFTER LABOUR CLEARANCE

Retention Money of the work shall not be refunded till the Contractor produces a clearance certificate from the concerned Labour Officer. As soon as the work is virtually complete, the Contractor shall apply for the clearance certificate to the concerned Labour Officer under intimation to the Engineer-In-Charge. The Engineer-In-Charge, on receipt of the said communication, shall write to the Labour Officer to intimate if any complaint is pending against the Contractor in respect of the work. If no complaint is pending, on record till three months after completion of the work and/or no communication is received from the Labour Officer to this effect till six months after the date of completion, it will be deemed to have received the clearance certificate and the Retention Money will be released if otherwise due.

### 35.0 SECURED ADVANCE AGAINST NON-PERISHABLE MATERIALS

Interest free secured advance up to a maximum of 75% (seventy five percent) of the Market Value of the materials or the cost of materials as derived from the tendered item rate of the Contractor, whichever is less, required for incorporation in the permanent works and brought to Site and duly certified by EPI Site Engineer shall be paid to the Contractor for all non-perishable items as per CPWD/MORTH (as the case may be) norms. The advance will be paid only on submission of Indemnity Bond in the prescribed pro-forma. The advance shall be recovered in full from next Running Account bill and fresh advance paid for the balance quantities of materials. The Contractor shall construct suitable godown at the Site of work for safe storage of the materials against any possible damages due to sun, rain, dampness, fire, theft etc. at his own cost. He shall also employ necessary watch & ward establishment for the purpose at his costs and risks. Such secured advance shall be payable on other items of perishable nature, fragile and combustible with the approval of the Engineer-In-Charge provided the Contractor provides a comprehensive insurance cover for the full cost of such materials. The decision of the Engineer-In-Charge shall be final and binding on the Contractor in this matter. No secured advance shall however, be paid on high-risk materials such as ordinary glass, sand, petrol, diesel etc.

### 36.0 MEASUREMENTS OF WORKS

36.1 Unless otherwise mentioned in the Bill of Quantities the measurements of works shall be done as per CPWD/MORTH specifications (as specified in Technical Specification of the Tender) and if the same is not given in the CPWD/MORTH Specifications, the same shall be measured as per latest relevant BIS codes in force. The quantity of steel reinforcement and the structural steel sections incorporated in the work shall be measured & paid on the basis of standard coefficients of sections as per BIS Codes of practice.
36.2 The Engineer-In-Charge shall except as otherwise stated ascertain and determine by measurement the value of work done in accordance with the contract.

36.3 All items having financial value shall be entered in Measurement Book, level book, etc. prescribed by EPI so that a complete record is obtained of all work performed under the contract. Items of non-financial value (which are not payable) may also be entered in Measurement Book at the sole discretion of the Engineer-In-Charge.

36.4 Measurements shall be taken jointly by the Engineer-In-Charge or his authorized representative and by the Contractor or his authorized representative.

36.5 Before taking measurements of any work the Engineer-In-Charge or the authorized person deputed by him for the purpose shall give a reasonable notice to the Contractor. If the Contractor fails to attend or send an authorized representative for measurement after such a notice or fails to countersign or to record the objection within a week from the date of measurement, then in any such event measurement taken by the Engineer-In-Charge or by the person deputed by him shall be taken to be correct measurements of the work.

36.6 The Contractor shall, without extra charge provide assistance with every appliance, labour and other things necessary for measurement.

Measurements shall be signed and dated by both parties each day on the Site on completion of measurement.

37.0 PAYMENTS

37.1 The bill shall be submitted by Contractor each month on or before the date fixed by the ENGINEER-IN-CHARGE for all works executed in previous months. The Contractor shall prepare computerized bills using the program as approved by Engineer-In-Charge as per prescribed format/ pro-forma. The Contractor shall submit five numbers of hard copies and one soft copy of floppy/ CD for all bills. Subject to clause 37.3 herein below, the payment due to the Contractor shall be made within fifteen days of getting the measurements verified from the Engineer-In-Charge or his subordinate/ representative and certification of bill by the Engineer-In-Charge.

37.2 All running payments shall be regarded as 'on account' payments against the final payment only and not as payments for work actually done and completed and / or accepted by EPI and shall not preclude the recovery for bad, unsound and imperfect or unskilled work to be removed and taken away and reconstructed or re-erected or be considered as an admission of the due performance of the Contract, or any part thereof, in this respect, or the accruing of any claim, nor shall it conclude, determine or affect in any way the powers of EPI under these conditions or any of them as to the final settlement and adjustments of the accounts or otherwise, or in any other way vary/ affect the contract. The final bill shall be submitted by the Contractor within three months of
the completion of work, otherwise EPI’s certificate of the measurement and of the total amount payable for the work accordingly shall be final and binding on Contractor. Each Running Bill should be accompanied by two sets of at-least 20 (twenty) photographs as per direction of Engineer-In-Charge taken from various points depicting status of work as on Report/ Bill date along with Monthly Progress Report for the concerned month in the pro-forma to be given/ approved by Engineer-In-Charge. Intermittent progress photographs as and when required shall also be provided by the Contractor at his own cost as per direction of Engineer-In-Charge. No payment of running account bill shall be released unless it is accompanied by progress photographs and Monthly Progress Report as above.

37.3 It is clearly agreed and understood by the Contractor that notwithstanding anything to the contrary that may be stated in the agreement between EPI and the Contractor, the Contractor shall become entitled to payment only after EPI has received the corresponding payment(s) from the Client/ Owner for the work done by the Contractor. Any delay in the release of payment by the Client/ Owner to EPI leading to delay in the release of the corresponding payment by EPI to the Contractor shall not entitle the Contractor to any compensation/ interest from EPI.

37.4 All payments shall be released by EPI by Account Payee Cheque from any of its offices in India directly at the address notified by the Contractor (Postage charges shall be charged to the Contractor’s account). In case of Payments is made by Demand Draft at the request of the Contractor, Bank Commission charges shall be debited to the account of Contractor.

38.0 WORK ON SUNDAYS, HOLIDAYS AND DURING NIGHT

For carrying out work on Sunday and Holidays or during night, the Contractor will approach the Engineer-In-Charge or his representative at least two days in advance and obtain his permission. The Engineer-In-Charge at his discretion can refuse such permission. The Contractor shall have no claim on this account whatsoever. If work demand, the Contractor shall make arrangements to carry out the work on Sundays, Holidays and in two, three shifts with the approval of Engineer-in- Charge at no extra cost to EPI.

39.0 NO IDLE CHARGES TOWARDS LABOUR OR PLANT & MACHINERY ETC.

No idle charges or compensation shall be paid for idling of the Contractor’s labour, staff or Plant & Machinery etc. on any ground or due to any reason whatsoever. EPI will not entertain any claim in this respect.

40.0 WORK TO BE EXECUTED IN ACCORDANCE WITH SPECIFICATIONS, DRAWINGS, ORDERS, ETC.

The Contractor shall execute the whole and every part of the work in the most substantial and workman like manner both as regards materials and otherwise in every respect in strict accordance with the specifications. The Contractor shall also conform exactly, fully and faithfully to the Design, Drawings and Instructions
in writing in respect of the work assigned by the Engineer-In-Charge and the Contractor shall be furnished free of charge one copy of the Contract Documents together with Specifications, Designs, Drawings.

The Contractor shall comply with the provisions of the contract and execute the works with care and diligence and maintain the works and provide all labour and materials, tools and plants including for measurements and supervision of all works, structural plans and other things of temporary or permanent nature required for such execution and maintenance in so far as the necessity for providing these is specified or is reasonably inferred from the contract. The Contractor shall take full responsibility for adequacy, suitability and safety of all the works and methods of construction.

41.0 DIRECTION FOR WORKS

41.1 All works to be executed under the contract shall be executed under the direction and subject to approval in all respect of the Engineer-In-Charge of EPI who shall be entitled to direct at what point or points and in what manner works are to be commenced and executed.

41.2 The Engineer-In-Charge and his representative shall communicate or confirm their instructions to the Contractor in respect of the execution of work during their Site inspection in a ‘Works Site Order Book’ maintained at the site office of Engineer-In-Charge. The Contractor or his authorized representative shall confirm receipt of such instructions by signing against the relevant orders in the book. The Contractor shall be bound to sign the site order book as and when required by Engineer-In-Charge and carry out compliance of instructions promptly to the satisfaction of Engineer-In-Charge.

42.0 ORDER OF PRECEDENCE OF DOCUMENTS

42.1 In case of difference, contradiction, discrepancy, dispute with regard to Conditions of Contract, Specifications, Drawings, Bill of Quantities and Rates quoted by the Contractor and other documents forming part of the contract, the following shall prevail in order of precedence.

i) Contract Agreement

ii) Fax, Telegram or Letter of Intent, detailed letter of Work Order along with statement of agreed variations and its enclosures.

iii) Description in Bill of Quantity / Schedule of Quantities

iv) Additional Conditions of Contract.

v) Technical specifications (General / Special Technical Specification) as given in the Tender Documents.

vi) General Conditions of Contract.

vii) Drawings

viii) CPWD/ MORTH specifications (as specified in Technical Specification of the Tender) update with correction slips issued up to last date of receipt of Tenders.
ix) Relevant B.I.S. Codes.

42.2 If there are varying or conflicting provisions made in any one document forming part of the contract, the Engineer-In-Charge shall be the deciding authority with regard to the intention of the document which shall be final and binding on the Contractor.

42.3 Any error in description, quantity or rate in the Schedule of Quantities/items or Bill of Quantities or any omission there from shall not vitiate the contract or release the Contractor from the execution of the whole or any part of the works comprised therein according to the Drawings and Specifications or from any of his obligations under the contract.

43.0 TIME SCHEDULE & PROGRESS

43.1 Time allowed for carrying out all the works as entered in the Tender shall be as mentioned in the “Memorandum” to the “Form of Tender” which shall be reckoned from the 10th day from the date on which the letter/telegram of Intent is issued to the Contractor. Time shall be the essence of the contract and Contractor shall ensure the completion of the entire work within the stipulated time of completion.

43.2 The Contractor shall also furnish within 10 days from the date of letter/telegram of Intent, a CPM network/PERT chart/Bar Chart for completion of work within stipulated time. This will be duly got approved from EPI. This approved Network/PERT Chart shall form a part of the agreement. Achievement of milestones as well as total completion has to be within the time period allowed.

43.3 Contractor shall mobilize and employ sufficient resources for completion of all the works as indicated in the agreed BAR CHART/Network. No additional payment will be made to the Contractor for any multiple shift work or other incentive methods contemplated by him in his work schedule even though the time schedule is approved by the Engineer-In-Charge.

43.4 During the currency of the work the Contractor is expected to adhere to the time schedule on milestones and total completion and this adherence will be a part of Contractor’s performance under the contract. During the execution of the work Contractor is expected to participate in the review and updating of the Network/BAR CHART undertaken by EPI. These reviews may be undertaken at the discretion of EPI either as a periodical appraisal measure or when the quantum of work order on the Contractor is substantially changed through deviation orders or amendments. The review shall be held at Site or any of the offices of EPI/Owner or Consultant of EPI/Owner at the sole discretion of EPI.

43.5 If at any time, it appears to the Engineer-In-Charge that the actual progress of work does not conform to the approved programme referred above, the Contractor shall produce a revised programme showing the modifications to the approved programme by additional inputs to ensure completion of the work within the stipulated time. The Contractor will adhere to the revised schedule thereafter. The approval to the revised schedule resulting in a completion date beyond the
stipulated date of completion shall not automatically amount to a grant of extension of time to the Contractor.

43.6 Contractor shall submit fortnightly/ Monthly (as directed by Engineer-In-Charge) progress reports (5 copies) on a computer based program (program and software to be approved by Engineer-In-Charge) highlighting status of various activities and physical completion of work.

43.7 The Contractor shall send completion report along with as built drawings and maintenance schedule to the office of Engineer-In-Charge, of EPI in writing within a period of 30 days of completion of work.

44.0 WATER AND ELECTRICITY

The Contractor shall make his own arrangement for Water & Electrical power for construction and other purposes at his own cost and pay requisite electricity and water charges. The Contractor shall also make standby arrangement for water & electricity to ensure un-interrupted supply.

45.0 MATERIALS TO BE PROVIDED BY THE CONTRACTOR

The Contractor shall, at his own expense, provide all materials, required including Cement & Steel for the works.

The Contractor shall at his own expense and without delay, supply to the Engineer-in-Charge samples of materials to be used on the work and shall get the same approved in advance. All such materials to be provided by the Contractor shall be in conformity with the specifications laid down or referred to in the contract. The Contractor shall, if requested by the Engineer-in-Charge furnish proof, to the satisfaction of the Engineer-In-Charge that the materials so comply.

The Contractor shall at his risk and cost submit the samples of materials to be tested or analyzed and bear all charges and cost of testing unless specifically provided for otherwise elsewhere in the contract or specifications. The Engineer-In-Charge or his authorized representative shall at all times have access to the works and to all workshops and places where work is being prepared or from where materials, manufactured articles or machinery are being obtained for the works and the Contractor shall afford every facility and every assistance and cost in obtaining the right and visit to such access.

The Engineer-In-Charge shall have full powers to require the removal from the premises of all materials which in his opinion are not in accordance with the specifications and in case of default, the Engineer-In-Charge shall be at liberty to employ at the expense of the Contractor, other persons to remove the same without being answerable or accountable for any loss or damage that may happen or arise to such materials. The Engineer-In-Charge shall also have full power to require other proper materials to be substituted thereof and in case of default, the Engineer-In-Charge may cause the same to the supplies and all
costs which may require such removal and substitution shall be borne by the Contractor.

45.1 CEMENT AND CEMENT GODOWN

Cement shall be procured by Contractor of 43 Grade conforming to BIS : 8112 Specification latest edition or higher Grade as directed by the Engineer-In-Charge. The cement shall be procured directly from the reputed manufacturers/stockist, which will have to be got approved from EPI in advance. Relevant vouchers and test certificates will be produced as and when required. The cement shall be stored by the Contractor in such suitable covered and lockable stores, well protected from climate and atmospheric effect. The cement godown shall be constructed by the Contractor as per CPWD specifications at his own cost. The cement will remain under double lock, one from EPI and other from Contractor. The cement in bags shall be stored in godowns in easy countable position. Cement bags shall be used on first in first out basis. Cement stored for beyond 90 days will be required to be tested at Contractors cost, before use in works.

45.2 STEEL & STEEL STOCKYARD

Steel conforming to BIS specifications (latest edition) shall be procured by the Contractor directly from reputed manufacturers/producers as approved by EPI. The manufacturer has to give a certificate that the material supplied is not a re-rolled product. Relevant vouchers & test certificates will be produced by the Contractor. Re-rolled sections will not be allowed.

Reinforcement steel, structural steel shall be stored and stacked in such manner so as to facilitate easy identification, removal etc. The Contractor shall take proper care to prevent direct contact between the steel and the ground/water for which he shall provide necessary arrangement at his own cost including ensuring proper drainage of area to prevent water logging as per directions of the Engineer-In-Charge. If required, the reinforcement steel shall also be protected, by applying a coat of neat cement slurry over the bars for which no extra payment shall be made.

Test certificates for each consignment of steel shall be furnished and tests to be got carried out by the Contractor at his own cost from the authorized laboratory as per the directions of Engineer-In-Charge, before incorporating the materials in the work.

46.0 SCHEDULE OF QUANTITIES / BILL OF QUANTITIES

46.1 The quantities shown against the various items of work are only approximate quantities, which may vary as per the actual requirement at Site.

46.2 All items of work in the Bill of Quantities/ schedule of quantities shall be carried out as per the CPWD/ MORTH (as the case may be) specifications, drawings and instructions of the ENGINEER-IN-CHARGE of EPI and the rates shall include for supply of required materials including proper storage, consumables, skilled & unskilled labour, supervision, tools, tackles, plant & machinery complete
as called for in the detailed specifications and conditions of the contract. No item, which is not covered in the Bill of Quantities, shall be executed by the Contractor without the approval of EPI. In case any Extra/Substituted item is carried out without specific-approval, the same will not be paid.

47.0 ANTI-TERMITE TREATMENT & WATER PROOF TREATMENT

47.1 Pre-construction treatment shall be carried out in co-ordination with the building work and shall be executed in such a manner that the civil works are not hampered or delayed by the anti-termite treatment. The treatment shall be carried out as detailed in BIS: 6313 (Part-II) latest revision. The waterproof treatment shall be of type and specifications as given in the schedule of quantities.

47.2 The treatment against water-proofing of basement, roofs, water retaining areas and termite infestation shall be and remain fully effective for a period of not less than 10(Ten) years to be reckoned from the date of expiry of the Defect Liability period, prescribed in the contract. At any time during the said guarantee period if EPI finds any defects in the said treatment or any evidence of re-infestation, dampness, leakage in any part of buildings or structure and notifies the Contractor of the same, the Contractor shall be liable to rectify the defect or give re-treatment at his own cost and shall commence the work or such rectification or re-treatment within seven days from the date of issue of such letter to him. If the Contractor fails to commence such work within the stipulated period, EPI may get the same done by another agency at the Contractor’s cost and risk and the decision of the Engineer-In-Charge of EPI for the cost payable by the Contractor shall be final and binding upon him.

47.3 Re-treatment if required shall be attended to and carried out by the Contractor within seven days of the notice from Engineer-In-Charge of EPI.

47.4 EPI reserves the right to get the quality of treatment checked in accordance with recognized test methods and in case it is found that the chemicals with the required concentration and rate of application have not been applied, or the water proof treatment is not done as per specifications, the Contractor will be required to do the re-treatment in accordance with the required concentration & specifications at no extra cost failing which no payment for such work will be made. The extent of work thus rejected shall be determined by EPI.

47.5 Water proofing and anti-termite treatment shall be got done through approved / specialized agencies only with prior approval of Engineer-In-Charge.

47.6 The Contractor shall make such arrangement as may be necessary to safeguard the workers and residents of the building against any poisonous effect of the chemicals used during the execution of the work.

47.7 During the execution of work, if any damage shall occur to the treatment already done, either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of Engineer-In-Charge by the Contractor at his cost.
47.8 The Contractor shall make his own arrangement for all equipments required for the execution of the job.

47.9 The Contractor shall execute Guarantee Bond in the prescribed form as appended for guaranteeing the anti-termite treatment and waterproof treatment.

48.0 **INDIAN STANDARDS**

Wherever any reference is made to any IS in any particular specifications, Drawings or Bill of Quantities, it means the Indian Standards editions with the amendments current at the last date of receipt of Tender Documents.

49.0 **CENTERING & SHUTTERING**

Marine plywood only or steel plates of minimum thickness as approved by Engineer-In-Charge shall be used for formwork. The shuttering plates shall be cleaned and oiled after every repetition and shall be used only after obtaining approval of EPI's Engineers at Site. The number of repetitions allowed for plywood and steel shuttering shall be at the discretion of Engineer-In-Charge of EPI depending upon the condition of shuttering surface after each use and the decision of ENGINEER-IN-CHARGE in this regard shall be final and binding on the Contractor. No claim whatsoever on this account shall be admissible.

50.0 **CONTROLLED MATERIALS**

50.1 The following Controlled materials shall be brought to Site after the approval of EPI.
   a) Water proofing compound.
   b) Cement
   c) Steel
   d) Primer/ Paints/ Varnish etc.
   e) Bitumen
   f) Chemical for anti termite treatment
   g) Any other materials as per discretion of EPI.

50.2 The quantity of Controlled materials shall be measured and recorded in the Measurement books and signed by the Contractor and the Engineer-In-Charge as a check to ensure that the required quantities as required for execution of works as per specifications have been brought to Site for incorporation in the work.

50.3 Controlled materials brought at Site shall be stored as directed by EPI and those already recorded in Measurement book, shall be suitably marked for identification.

50.4 The Contractor shall ensure that the Controlled materials are brought to Site in original sealed containers or packing bearing manufacturer’s markings and
brands (except where the quantity required is a fraction of the smallest packing). Materials not complying with this requirement shall be rejected. The empty containers of such Controlled materials shall not be destroyed/ disposed-off without the written permission of EPI.

50.5 The Contractor shall produce receipted vouchers showing quantities of the materials to satisfy Engineer-In-Charge that the materials comply with the specifications. These vouchers shall be endorsed, dated and initialed by Engineer-In-Charge giving the contract number and name of work and a certified copy of each such voucher signed both by EPI and the Contractor shall be kept on record.

50.6 When the cost of each category of materials is less than Rs.5000/- production of vouchers may not be insisted upon if EPI is otherwise satisfied with the quality and quantity of materials.

51.0 RECORDS OF CONSUMPTION OF CEMENT & STEEL

51.1 For the purpose of keeping a record of cement and steel received at Site and consumption in works, the Contractor shall maintain a properly bound register in the form approved by EPI, showing columns like quantity received and used in work and balance in hand etc. This register shall be signed daily by the Contractor’s representative and EPI’s representative.

51.2 The register of cement & steel shall be kept at Site in the safe custody of EPI’s Engineer during progress of the work. This provision will not, however, absolve the Contractor from the quality of the final product.

51.3 In case cement or steel quantity consumed is lesser as compared to the theoretical requirement of the same as per CPWD/MORTH (as the case may be) specifications/ norms, the work will be devalued and/ or a penal rate (i.e. double the rate at which cement/ steel purchased last) recovery for lesser consumption of cement/ steel shall be made in the item rates of the work done subject to the condition that the tests results fall within the acceptable criteria as per CPWD/MORTH (as the case may be) specifications otherwise the work shall have to be dismantled and redone by the Contractor at no extra cost.

In case of cement, if actual consumption is less than 98% of the theoretical consumption, a recovery shall be effected from the Contractor’s dues at the penal rate for the actual quantity that is lower than 98% of theoretical consumption.

52.0 MATERIALS AND SAMPLES

52.1 The materials/ products used on the works shall be one of the approved make/ brands out of list of manufacturers/ brands/ makes given in the Tender Documents. The Contractor shall submit samples/ specimens out of approved makes of materials/ products to the Engineer-In-Charge for prior approval. In
exceptional circumstances Engineer-In-Charge may allow alternate equivalent makes/ brands of products/ materials at his sole discretion. The final choice of brand/ make shall remain with the Engineer-In-Charge, whose decision in this matter shall be final and binding and nothing extra on this account shall be payable to the Contractor.

In case single brand/ make is mentioned, other equivalent makes/ brands may be considered by the Engineer-In-Charge with prior approval. In case of variance in CPWD/ IS/BIS Specifications from approved products/ makes specification, the specification of approved product/ make shall prevail for which nothing shall be paid extra to the Contractor.

In case no make or brand of any materials, articles, fittings and accessories etc. is specified, the same shall comply with the relevant Indian Standard Specifications and shall bear the ISI/BIS mark. The Engineer of EPI and the Owner shall have the discretion to check quality of materials and equipments to be incorporated in the work, at source of supply or site of work and even after incorporation in the work. They shall also have the discretion to check the workmanship of various items of work to be executed in this work. The Contractor shall provide the necessary facilities and assistance for this purpose.

52.2 The above provisions shall not absolve the Contractor from the quality of final product and in getting the material and workmanship quality checked and approved from the Engineer-In-Charge of EPI.

52.3 The Contractor shall well in advance, produce samples of all materials, articles, fittings, accessories etc. that he proposes to use and get them approved in writing by EPI. The materials articles etc. as approved shall be labelled as such and shall be signed by EPI and the Contractor's representative.

52.4 The approved samples shall be kept in the custody of the Engineer- in-Charge of EPI till completion of the work. Thereafter the samples except those destroyed during testing shall be returned to the Contractor. No payment will be made to the Contractor for the samples or samples destroyed in testing.

52.5 The brands of all materials, articles fittings etc. approved together with the names of the manufacturers and firms from which supplies have been arranged shall be recorded in the Site Order Book.

52.6 The Contractor shall set up and maintain at his cost, a field testing laboratory for all day-to-day tests at his own cost to the satisfaction of the Engineer-In-Charge. This field testing laboratory shall be provided with equipment and facilities to carry out all mandatory field tests as per CPWD/MORTH (as the case may be) specifications. The laboratory building shall be constructed and installed with the appropriate facilities; Temperature and humidity controls shall be available wherever necessary during testing of samples.

All equipments shall be provided by the Contractor so as to be compatible with the testing requirements specified. The Contractor shall maintain all the equipments in good working condition for the duration of the contract.
The Contractor shall provide approved qualified personnel to run the laboratory for the duration of the Contract. The number of staff and equipment available must at all times be sufficient to keep pace with the sampling and testing programme as required by the Engineer-In-Charge.

The Contractor shall fully service the site laboratory and shall supply everything necessary for its proper functioning, including all transport needed to move equipment and samples to and from sampling points on the Site, etc.

The Contractor shall re-calibrate all measuring devices whenever so required by the Engineer-In-Charge and shall submit the results of such measurements without delay.

All field tests shall be carried out in the presence of EPI’s representative. All costs towards samples, materials, collection, transport, manpower, testing, including concrete mix-design etc. shall be borne by the Contractor and are deemed to be included in the rates quoted by him in the Bill of Quantities.

53.0 TESTS AND INSPECTION

53.1 The Contractor shall carry out the various mandatory tests as per specifications and the technical documents that will be furnished to him during the performance of the work. All the tests on materials, as recommended by CPWD, MORTH (as the case may be) and relevant Indian Standard Codes or other standard specifications (including all amendments current at the last date of submission of Tender Documents) shall be got carried out by the Contractor at the field testing laboratory or any other recognized institution/laboratory, at the direction of EPI. All testing charges, expenses etc. shall be borne by the Contractor. All the tests, either on the field or outside laboratories concerning the execution of the work and supply of materials shall be got carried out by the Contractor or EPI at the cost of the Contractor.

53.2 WORKS TO BE OPEN TO INSPECTION

All works executed or under the course of execution in pursuance of this contract shall at all times be open to inspection and supervision of EPI. The work during its progress or after its completion may also be inspected, by Chief Technical Examiner of Government of India (CTE) and/ or an inspecting authority of State Government of State in which work is executed and/or by third party checks by Owner/ Clients. The compliance of observations/improvements as suggested by the inspecting officers of EPI/CTE/ State authorities/ Owners shall be obligatory on the part of the Contractor at the cost of Contractor.

54.0 BORROW AREAS

The Contractor shall make his own arrangements for borrow pits and borrow disposal areas including their approaches and space for movement of men, machinery, other equipments as required for carrying out the works. The Contractor shall be responsible for taking all safety measures, getting approval,
making payment of royalties, charges etc. and nothing extra shall be paid to the Contractor on this account and unit rates quoted by the Contractor for various items of Bill of Quantities shall be deemed to include the same.

55.0 BITUMEN WORK

The Contractor shall be responsible for arranging Bitumen/Tar of required grade from source to be approved by the Engineer-In-Charge. No Bitumen work shall be carried out on wet surface or in rainy conditions.

56.0 CARE OF WORKS

From the commencement to the completion of works and handing over, the Contractor shall take full responsibility for care of all the works and in case of any damage/loss to the works or to any part thereof or to any temporary works due to lack of precautions or due to negligence on part of Contractor, the same shall be made good by the Contractor at his own cost.

57.0 WORK IN MONSOON AND DEWATERING

The execution of the work may entail working in the monsoon also. The Contractor must maintain labour force as may be required for the job and plan and execute the construction and erection according to the prescribed schedule. No special/ extra rate will be considered for such work in monsoon. The Contractor’s rate shall be considered inclusive of cost of dewatering required, if any and no extra rate shall be payable on this account.

58.0 NO COMPENSATION FOR FORECLOSURE/CANCELLATION/ REDUCTION OF WORKS

If at any time after the commencement of the work EPI shall for any reason whatsoever is required to abandon the work or does not require the whole work thereof as specified in the Tender to be carried out, the Engineer-In-Charge shall give notice in writing of the fact to the Contractor, who shall have no claim to any payment of compensation whatsoever on account of any profit or advantage which he might have derived from the execution of the work in full, but which he did not derive in consequence of the full amount of the work not having been carried out or on foreclosure, neither shall he have any claim for compensation by reason of any alterations having been made in the original Specifications, Drawings, Designs and Instructions which shall involve any curtailment of the work as originally contemplated.

Provided that the Contractor shall be paid the charges on the cartage only of materials actually and bonafide brought to the Site of the work by the Contractor and rendered surplus as a result of the abandonment or curtailment of the work or any portion thereof and then taken back by the Contractor, provided however, that the Engineer-In-Charge shall have in all such cases the option of taking over all or any such materials at their purchase price or at local current rates whichever may be less. In the case of such stores having been issued by EPI
and returned by the Contractor to EPI, credit will be given to him by the Engineer-In-Charge at rates not exceeding those at which they were originally issued to him after taking into consideration any deduction for claims on account of any deterioration or damage while in the custody of the Contractor and in this respect the decision of the Engineer-In-Charge shall be final.

59.0 RESTRICTION ON SUBLETTING

59.1 The Contractor shall not sublet or assign the whole or part of the works except where otherwise provided, by the contract and even then only with the prior written consent of EPI and such consent if given shall not relieve the Contractor from any liability or obligation under the contract and he shall be responsible for the acts, defaults or neglects of any sub-Contractor, his agents, servants or workmen as full as if they were the acts, defaults or neglects of the Contractor, his agent, servants or workmen provided always that the provision of labour on piece work basis shall not be deemed to be a subletting under this clause.

59.2 The Contractor may entrust specialist items of works to the agencies specialized in the specific trade. The Contractor shall give the names and details of such firm whom he is going to employ for approval of EPI. These details shall include the expertise, financial status, technical manpower, equipment, resources and list of works executed and on hand of the specialist agency. Specialist agency shall be engaged only after obtaining written approval of the Engineer-In-Charge.

60.0 PROHIBITION OF UNAUTHORISED CONSTRUCTION & OCCUPATION

No unauthorized buildings, structures should be put up by the Contractor anywhere on the project Site, neither any building built by him shall be unauthorisedly occupied by him or his staff.

61.0 CO-ORDINATION WITH OTHER AGENCIES

Work shall be carried out in such a manner that the work of other Agencies operating at the Site is not hampered due to any action of the Contractor. Proper Co-ordination with other Agencies will be Contractor's responsibility. In case of any dispute the decision of EPI shall be final and binding on the Contractor. No claim whatsoever shall be admissible on this account.

62.0 SETTING OUT OF THE WORKS

62.1 The Contractor shall be responsible for the true and proper setting out of the works and for the correctness of the position, levels, dimensions and alignment of all parts of the works. If at any time during the progress of works, shall any error appear or arise in the position, levels, dimensions or alignment of any part of the works, the Contractor shall at his own expenses rectify such error to the satisfaction of Engineer-in-charge. The checking of any setting out or of any line or level by the engineers of EPI shall not in any way relieve the Contractor of his responsibility for the correctness.
62.2 Contractor shall provide permanent bench marks, flag tops and other reference points for the proper execution of work and these shall be preserved till the end of work. All such reference points shall be in relation to the levels and locations, given in the Architectural, Plumbing and other services Drawings.

63.0 NOTICE BEFORE COVERING UP THE WORK

The Contractor shall give not less than seven days notice before covering up or otherwise placing beyond the reach of measurement any work, to the Engineer-In-Charge in order that the same may be inspected and measured. If any work is covered up or placed beyond the reach of Inspection/ measurement without such notice to the Engineer-In-Charge or his consent being obtained, the same shall be uncovered at the Contractors expenses and he shall have to make it good at his own expenses.

64.0 SITE CLEARANCE

64.1 The Contractor shall ensure that the working Site is kept clean and free of obstructions for easy access to job Site and also from safety point of view. Before handing over the work to EPI the Contractor shall remove all temporary structures like the site offices, cement godown, stores, labour huts, scaffolding rubbish, left over materials tools and plants, equipments etc., clean and grade the Site to the entire satisfaction of the Engineer-In-Charge. If this is not done the same will be got done by EPI at his risk and cost.

64.2 The Contractor shall clean all floors, remove cement/ lime/ paint drops and deposits, clean joinery, glass panes etc., touching all painter’s works and carry out all other necessary items of works to make the premises clean and tidy before handing over the building, and the rates quoted by the Contractor shall be deemed to have included the same.

65.0 VALUABLE ARTICLES FOUND AT SITE

All gold, silver and other minerals of any description and all precious stones, coins, treasure, relics, antiques and all other similar things which shall be found in, under or upon the Site, shall be the property of the Owner/ Government and the Contractor shall duly preserve the same to the satisfaction of Engineer-In-Charge and shall from time to time deliver the same to such person or persons indicated by EPI.

66.0 MATERIALS OBTAINED FROM DISMANTLEMENT TO BE OWNER’S PROPERTY

All materials like stone, boulders and other materials obtained in the work of dismantling, excavation etc. will be considered Owner/ government property and may be issued to the Contractor by the Owner/ EPI, if required for use in this work at rates approved by EPI or the Contractor may be asked to dispose off these items at his cost.

67.0 SET-OFF OF CONTRACTOR’S LIABILITIES

EPI shall have the right to deduct or set off the expenses incurred or likely to be incurred by it in rectifying the defects and/or any claim under this agreement.
against the Contractor from any or against any amount payable to the Contractor under this agreement including Retention Money and proceeds of Security Deposit cum Performance Guarantee and from any other contract being executed by the Contractor for EPI.

68.0 MATERIALS PROCURED WITH THE ASSISTANCE OF EPI

If any material for the execution of this contract is procured with the assistance of EPI either by issue from its stores or purchase made under orders or permits or licences obtained by EPI, the Contractor shall hold and use the said materials economically and solely for the purpose of this contract and shall not dispose them without the written permission of Engineer-In-Charge. The Contractor, if required by EPI, shall return all such surplus or unserviceable materials that may be left with him after the completion of the contract or at its termination on whatsoever reason, on being paid or credited such price as EPI shall determine having due regard to the conditions of materials.

69.0 ALTERATION IN SPECIFICATION, DESIGN & DRAWING

69.1 The Engineer-In-Charge shall have power to make any alterations in, omissions from, additions to or substitutions for, the original Specifications, Drawings, Designs and Instructions that may appear to him to be necessary during the progress of the work, and the Contractor shall carry out the work in accordance with any instructions which may be given to him in writing signed by the Engineer-In-Charge and such alterations, omissions, additions, or substitutions shall not invalidate the contract and any altered, additional or substituted work which the Contractor may be directed to do in the manner above specified as part of the work shall be carried out by the Contractor on the same conditions in all respects on which he agreed to do the main work.

The time for the completion of the work shall be extended in the proportion that the altered, additional or substituted work price bears to the original contract work price, and the certificate of the Engineer-In-Charge shall be conclusive as to such proportion. Over and above this, a further period to the extent of 25 percent of such extension shall be allowed to the Contractor.

The rates for such additional, altered or substituted work under this clause shall be worked out in accordance with the following provisions in their respective order:

i) If the rates for the additional, altered or substituted work are specified in the contract for the work, the Contractor is bound to carry out the additional, altered or substituted work at the same rates as are specified in the contract for the work.

ii) If the rates for the additional, altered or substituted work are not specifically provided in the contract for the work, the rates will be derived from the rates for a nearest similar item of work as are specified in the contract for the work. In case of composite tenders where two or more
schedule of quantities/ Bill of Quantities form part of the contract, the rates shall be derived from the nearest similar item in the schedule of quantities/Bill of Quantities of the particular part of work in which the deviation is involved failing that from the lowest of the nearest similar item in other schedule of quantity. The opinion of the Engineer-In-Charge as to whether or not the rate can be reasonably so derived from the item in this contract will be final and binding on the Contractor.

iii) If the altered, additional or substituted work includes any work for which no rate is specified in the contract for the work and which cannot be derived in the manner specified in sub para (i) and (ii) above from the similar class of work in the contract then such work shall be carried out at the rates entered in the Schedule of Rates (as mentioned in “Memorandum” to the “Form of Tender” for Civil/ Sanitary Works) minus/plus the percentage which the tendered amount of scheduled items bears with the estimated amount of schedule items based on the Schedule of Rates ( as mentioned in “Memorandum” to the “Form of Tender” for Civil/ Sanitary Works ). The scheduled items mean the items appearing in the Schedule of Rates (as mentioned in “Memorandum” to the “Form of Tender” for Civil/ Sanitary Works), which shall be applicable in this clause. This clause will apply mutatis mutandis to electrical work except that Electrical Schedule of Rates as mentioned in “Memorandum” to the “Form of Tender” will be considered in place of Civil/ Sanitary works Schedule of rates as mentioned in “Memorandum” to the “Form of Tender”.

iv) If the rates for the altered, additional or substituted work cannot be determined in the manner specified in sub-clauses (i) to (iii) above, then the Contractor shall, within 7 days of the date of receipt of order to carry out the work, inform the Engineer-In-Charge the rates which he intends to charge for such class of work, supported by analysis of the rate or rates claimed, and the Engineer-In-Charge shall determine the rate or rates on the basis of prevailing market rates of the material, Labour, T&P etc. plus 10% (Ten percent) to cover the Contractors supervision, overheads and profit and pay the Contractor accordingly. The opinion of the Engineer-In-Charge as to the current market rates of materials and quantum of labour involved per unit of measurements will be final and binding on the Contractor.

However, the Engineer-In-Charge, by notice in writing, will be at liberty to cancel his order to carry out such class of work and arrange to carry it out in such manner, as he may consider advisable. But under no circumstances, the Contractor shall suspend the work on the plea of non-settlement of rates of items falling under the clause.

v) Except in case of items relating to foundations, provisions contained in sub-clauses (i) to (iv) above shall not apply to contract, altered or substituted items as individually exceed the ‘deviation limit’ of plus/minus 25% (Twenty Five Percent) subject to the following:-

(a) Deviation limit shall apply to individual items.
(b) The value of additions of items, of any individual trade not already included in the contract, shall not exceed 20% of the Tendered value of work, subject to overall deviation limit as given above.

Provided further that in case where the original item is substituted, the Substituted Item shall be deemed to have replaced the original item in the contract itself to that extent and above provisions pertaining to the deviations shall apply with respect to such Substituted Item and not the original item.

NOTE: Individual trade means the trade section to which Bill of Quantities annexed to the agreement has been divided or in the absence of any such division the individual section of the MORTH/C.P.W.D. (as the case may be) Scheduled of rates specified above, such as excavation and earthwork, Concrete, wood work and joinery, etc.

The rate of any such work except the items relating to foundations which is in excess of the deviation limit and deviation in quantities of AHR items on plus side as contained in Clause 9.2(i) shall be determined in accordance with the provisions contained in Clause 69.2.

69.2 In the case of contract items, substituted items, Contract cum substituted items or additional items which exceed the limits laid down in sub para (v) of condition 69.1 above (except the items relating to foundation work, which the Contractor is required to do under Clause 69.1 above and deviation in quantities of AHR items on plus side as contained in clause 9.2 (i) ), the Contractor may within fifteen days of receipt of order or occurrence of the excess, claim revision of the rates, supported by proper analysis, for the work in excess of the above mentioned limits, provided that if the rates so claimed are in excess of the rates specified in the schedule of quantities or those derived in accordance with the provisions of sub para (i) to (iii) of conditions 69.1 by more than five percent, the Engineer-In-Charge shall within three months of receipt of the claims supported by analysis, after giving consideration to the analysis of the rates submitted by the Contractor, determine the rates on the basis of the market rates and if the rates so determined exceed the rates specified in the schedule of quantities or those derived in accordance with the provisions of sub paras (i) to (iii) of condition 69.1 by more than five percent, the contract shall be paid in accordance with the rates determined. In the event of the Contractor failing to claim revision of rates within the stipulated period, or if the rates determined by the Engineer-In-Charge within the period of three months of receipt of the claims supported by analysis are within five percent of the rates specified in the schedule of quantities or of those determined in accordance with the provisions of sub-para (i) to (iii) of condition 69.1, the Engineer-In-Charge shall make payment at the rates as specified in the schedule of quantities or those already determined under sub para (i) to (iii) of condition 69.1 for the quantities in excess of the limits laid down in sub para (v) of condition 69.1.

69.3 The provisions of the proceeding paragraph shall apply to the decrease in the rates of items for the work in excess of the limits laid down in sub para (v) of
condition 69.1 provided that such decrease is more than five percent of rates specified in the schedule of quantities or those derived in accordance with the provisions of sub para (i) to (iii) of condition 69.1 and the Engineer-In-Charge may after giving notice to the Contractor within two months of receipt of order by the Contractor or occurrence of the excess and after taking into consideration any reply received from him within fifteen days of receipt of the notice revise the rates for the work in question within two months of expiry of the said period of fifteen days having regard to the market rates.

69.4 The Contractor shall send to the Engineer-In-Charge once every three months an up to date account giving complete details of all claims for additional payments to which the Contractor may consider himself entitled and of all additional work ordered by the Engineer-In-Charge which he has executed during the preceding quarter failing which the Contractor shall be deemed to have waived his right.

69.5 For the purpose of operation of clause 69.1 (v) the following works shall be treated as works relating to foundation:-

i) For buildings, compound walls plinth level or 1.2 meters (4 feet) above ground level whichever is lower excluding items of flooring and D.P.C. but including base concrete below the floors.

ii) For abutments, piers, retaining walls of culverts and bridges, walls of water reservoirs the bed of floor level.

iii) For retaining walls where floor level is not determinate 1.2 meters above the average ground level or bed level.

iv) For Roads all items of excavation and filling including treatment of sub base and soiling work.

v) For water supply lines, sewer lines, under-ground storm water drains and similar works. All items of work below ground level except items of pipe work, masonry work.

vi) For open storm water drains, all items of work except lining of drains.

70.0 ACTION AND COMPENSATION PAYABLE IN CASE OF BAD WORK

If it shall appear to the Engineer-In-Charge or his authorized subordinate in charge of the work or to the Chief Technical Examiner or to any other inspecting agency of Government/ State Government/ Owner where the work is being executed, that any work has been executed with unsound, imperfect, or unskillful workmanship or with materials of any inferior description, or that any materials or articles provided by him for the execution of the work are unsound or of a quality inferior to that contracted for or otherwise not in accordance with the contract, the Contractor shall on demand in writing which shall be made within six months of the completion of the work from the ENGINEER-IN-CHARGE specifying the work, materials or articles complained of notwithstanding that the same may have been passed, Certified and paid for forthwith rectify, or remove and
reconstruct the work so specified in whole or in part as the case may require or as the case may be, remove the materials or articles so specified and provide other proper and suitable materials or articles at his own proper charge and cost, and in the event of his failing to do so within a period to be specified by the Engineer-In-Charge in his demand aforesaid, then the Contractor shall be liable to pay compensation at the rate of one percent of the estimated amount put to tender for every day not exceeding ten days, while his failure to do so shall continue and in the case of any such failure, the Engineer-In-Charge may rectify or remove and re-execute the work or remove and replace with others, the material or articles complained of as the case may be at the risk and expense in all respects of the Contractor.

71.0 POSSESSION PRIOR TO COMPLETION

71.1 EPI shall have the right to take possession of or use any completed or partially completed work or part of the work. Such possession or use shall not be deemed to be any acceptance of any work not completed in accordance with the contract agreement. If such prior possession or use by EPI delays the progress of work an equitable adjustment in the time of completion will be made and the contract agreement shall be deemed to be modified accordingly. The decision of EPI in this case shall be final binding and conclusive.

71.2 When the whole of the works or the items or the groups of items of work for which separate periods of completion have been specified have been completed the Contractor will give a notice to that effect to the Engineer in writing. The Engineer shall within 15 days of the date of receipt of such notice inspect the works and either the Engineer-In-Charge issues to the Contractor a completion certificate stating the date on which in his opinion the works were completed in accordance with the contract or gives instructions in writing to the Contractor specifying the balance items of work which are required to be done by the Contractor before completion certificate could be issued. The Engineer-In-Charge shall also notify the Contractor of any defect in the works affecting completion.

71.3 The Contractor shall during the course of execution prepare and keep updated a complete set of ‘as built’ drawings to show each and every change from the Contract Drawings, changes recorded shall be countersigned by the Engineer-In-Charge and the Contractor. Four copies of ‘as built’ drawings shall be supplied to EPI by the Contractor within 30 days of the completion. All costs incurred in this respect shall be borne by the Contractor only.

72.0 COMPENSATION FOR DELAY AND REMEDIES

72.1 If the Contractor fails to maintain the required progress in terms of clause 72.4 or relevant clause of Additional Conditions of Contract, to complete the work and clear the Site on or before the completion date or extended date of completion, he shall, without prejudice to any other right or remedy available under the law to EPI on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below or such smaller amount as the Engineer in charge (whose decision in writing shall be final and binding) may decide on the amount of tendered value of the work for every completed day / week (as
applicable) that the progress remains below that specified in Clause 72.4.1 or the relevant clause in Additional Conditions of Contract or that the work remains incomplete. This will also apply to items or group of items for which a separate period of completion has been specified.

i) For works with completion period not exceeding 3 month (as originally stipulated) @ 1% per day

ii) For works with completion period exceeding 3 months (as originally stipulated) @ 1% per week or part thereof

Provided always that the total amount of compensation for delay to be paid under this Condition shall not exceed 10% of the Tendered Value of work or of the Tendered Value of the item or group of items of work for which a separate period of completion is originally given.

The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this or any other contract with EPI even after completion of the work.

72.2 CANCELLATION / DETERMINATION OF CONTRACT IN FULL OR PART

Subject to other provisions contained in this clause, the Engineer-In-Charge may, without prejudice to his any other rights or remedy against the Contract in respect of any delay, inferior workmanship, any claims for damages and / or any other provisions of this contract or otherwise, and whether the date of completion has or has not elapsed, by notice in writing absolutely determine the contract in full or in part in any of the following cases:

i) If the Contractor having been given by the Engineer-In-Charge a notice in writing to rectify, reconstruct or replace any defective work or that the work is being performed in an inefficient or otherwise improper or un-workmanlike manner shall omit to comply with the requirement of such notice for a period of seven days thereafter; or

ii) If the Contractor has, without reasonable cause, suspended the progress of the work or has failed to proceed with the work with due diligence so that in the opinion of the ENGINEER-IN-CHARGE (which shall be final and binding) he will be unable to secure completion of the work by the date for completion and continues to do so after a notice in writing of seven days from the Engineer-In-Charge; or

iii) If the Contractor fails to complete the work within the stipulated date or items of work with individual date of completion, if any stipulated, on or before such date(s) of completion and does not complete them within the period specified in a notice given in writing in that respect by the Engineer-In-Charge; or

iv) If the Contractor persistently neglects to carry out his obligations under the contract and / or commits default in complying with any of the terms
and conditions of the contract and does not remedy it or take effective steps to remedy it within 7 days after a notice in writing is given to him in that respect by the Engineer-In-Charge; or

v) If the Contractor shall offer or give or agree to give to any person in EPI service or to any other person on his behalf any gift or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to do any action in relation to the obtaining or execution of this or any other contract for EPI; or

vi) If the Contractor shall enter into a contract with EPI in connection with which commission has been paid or agreed to be paid by him or to his knowledge, unless the particulars of any such commission and the terms of payment thereof have been previously disclosed in writing to the Engineer-In-Charge; or

vii) If the Contractor shall obtain a contract with EPI as a result of wrong tendering or other non-bona-fide methods of competitive tendering; or

viii) If the Contractor being an individual, or if a firm, any partner thereof shall at any time be adjudged insolvent or have a receiving order or order for administration of his estate made against him or shall take any proceedings for liquidation or composition (other than a voluntary liquidation for the purpose of amalgamation or reconstruction) under any Insolvency Act for the time being in force or make any conveyance or assignment of his effects or composition or arrangement for the benefit of his creditors or purport so to do, or if any application be made under any Insolvency Act for the time being in force for the sequestration of his estate or if a trust deed be executed by him for benefit of his creditors; or

ix) If the Contractor being a company, shall pass a resolution or the Court shall make an order for the winding up of the company, or a receiver or manager on behalf of the debenture holders or otherwise shall be appointed or circumstances shall arise which entitle the Court or debenture holders to appoint a receiver or manager; or

x) If the Contractor shall suffer an execution being levied on his goods and allow it to be continued for a period of 21 days; or

xi) If the Contractor assigns, transfers, sublets (engagement of labour on a piece-work basis or of the labour with materials not to be incorporated in the work, shall not be deemed to be subletting) or otherwise parts with or attempts to assign, transfer sublet or otherwise parts with the entire works or any portion thereof without and prior written approval of the Engineer-In-Charge.

When the Contractor has made himself liable for action under any of the clauses aforesaid, the Engineer-In-Charge may without prejudice to any other right or remedy which shall have accrued or shall accrue hereafter to EPI, by a notice in
writing to cancel the contract as a whole or only such items of work in default from the Contract.

The Engineer-In-Charge shall on such cancellation by EPI have powers to:

a) Take possession of Site and any materials, Construction Plant & machinery, implements, stores, etc. thereon; and/ or

b) Carry out the incomplete work by any means at the risk and cost of the Contractor; and/ or

c) To determine or rescind the contract as aforesaid (of which termination or rescission notice in writing to the Contractor under the hand of the Engineer-In-Charge shall be conclusive evidence). Upon such determination or rescission the full Retention Money recovered by EPI under the contract and Security Deposit cum Performance Guarantee shall be liable to be forfeited and un-used materials, construction plant & machinery, implements, temporary buildings, etc. shall be taken over and shall be absolutely at the disposal of EPI. If any portion of the Retention Money has not been received or recovered by EPI from RA Bills, it would be called for and forfeited; and/ or

d) To employ labour and to supply materials, equipment to carry out the work or any part of the work debiting the Contractor with the cost of the labour and the price of the materials, equipment rentals (of the amount of which cost and price certified by the Engineer-In-Charge shall be final and conclusive) against the Contractor and crediting him with the value of the work done in all respects in the same manner and at the same rates as if it had been carried out by the Contractor under the terms of his contract. The certificate of the Engineer-In-Charge as to the value of the work done shall be final and conclusive against the Contractor provided always that action under the sub-clause shall only be taken after giving notice in writing to the Contractor. Provided also that if the expenses incurred by the EPI are less than the amount payable to the Contractor at his agreement rates, the difference shall not be paid to the Contractor; and/ or

e) After giving notice to the Contractor to measure up the work of the Contractor and to take such whole, or the balance or part thereof as shall be un-executed or delayed with reference to the General Conditions of Contract clause no. 72.4.1 and/ or relevant clause of Additional Conditions of Contract, out of his hands and to give it to another Contractor to complete in which case any expenses which may be incurred in excess of the sum which would have been paid to the original Contractor if the whole work had been executed by him (of the amount of which excess the certificate in writing of the Engineer-In-Charge shall be final and conclusive) shall be borne and paid by the original Contractor and may be deducted from any money due to him by EPI under his contract or on any other account whatsoever or from his Retention Money, Security Deposit cum Performance Guarantee or the proceeds of sales of unused materials, construction plants & machinery, implements temporary buildings etc. thereof or a sufficient part thereof as
the case may be. If the expenses incurred by EPI are less than the amount payable to the Contractor at his agreement rates, the difference shall not be paid to the Contractor; and/or

f) By a notice in writing to withdraw from the Contractor any items or items of work as the Engineer-In-Charge may determine in his absolute discretion and get the same executed at the risk and cost of the Contractor.

Any excess expenditure incurred or to be incurred by EPI in completing the works or part of the works or the excess loss or damages suffered or may be suffered by EPI as aforesaid after allowing such credit shall without prejudice to any other right or remedy available to EPI in law be recovered from any moneys due to the Contractor on any account, and if such moneys are not sufficient the Contractor shall be called upon in writing and shall be liable to pay the same within 30 days.

If the Contractor shall fail to pay the required sum within the aforesaid period of 30 days, the Engineer-In-Charge shall have the right to sell any or all of the Contractors unused materials, Construction Plant, machinery, implements, temporary buildings, etc. and apply the proceeds of sale thereof towards the satisfaction of any sums due from the Contractor under the contract and if thereafter there be any balance outstanding from the Contractor, it shall be recovered in accordance with the provisions of the contract and law.

Any sums in excess of the amounts due to EPI and unsold materials, Construction Plant etc. shall be returned to the Contractor, provided always that if cost or anticipated cost of completion by EPI of the works or part of the works is less than the amount which the Contractor would have been paid had he completed the works or part of the works, such benefit shall not accrue to the Contractor.

In the event of anyone or more of the above courses being adopted by the Engineer-In-Charge the Contractor shall have no claim to compensation whatsoever for any loss sustained by him by reasons of his having purchased or procured any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of the contract. And in case action is taken under any of the provision aforesaid the Contractor shall not be entitled to recover or be paid any sum for any work thereof or actually performed under this contract unless and until the Engineer-In-Charge has certified in writing the performance of such work and the value payable in respect thereof and he shall only be entitled to be paid the value so certified. Provided further that if any of the recoveries to be made, while taking action as per (d) and/or (e) above, are in excess of the Retention Money & Security Deposit cum Performance Guarantee forfeited, these shall be limited to the amount by which the excess cost incurred by the EPI exceeds the Retention Money & Security Deposit cum Performance Guarantee so forfeited.
72.3 CONTRACTOR LIABLE TO PAY COMPENSATION EVEN IF ACTION NOT TAKEN

In any case in which any of the powers conferred upon the Engineer-In-Charge by relevant clause thereof, shall have become exercisable and the same are not exercised, the non-exercise thereof shall not constitute a waiver of any of the conditions hereof and such powers shall notwithstanding be exercisable in the event of any future case of default by the Contractor and the liability of the Contractor for compensation shall remain unaffected. In the event of the Engineer-In-Charge putting in force all or any of the powers vested in him under the preceding clause he may, if he so desires after giving a notice in writing to the Contractor, take possession of (or at the sole discretion of the Engineer-In-Charge which shall be final and binding on the Contractor) use as on hire (the amount of the hire money being also in the final determination of the Engineer-In-Charge) all or any tools, plant, machinery, materials and stores, in or upon the works, or the site thereof belonging to the Contractor, or procured by the Contractor and intended to be used for the execution of the work / or any part thereof, paying or allowing for the same in account at the contract rates, or in the case of these not being applicable, at current market rates to be certified by the Engineer-In-Charge, whose certificate thereof shall be final, and binding on the Contractor and/or direct the Contractor, clerk of the works, foreman or other authorized agent to remove such tools, machinery, plant, materials, or stores from the premises (within a time to be specified in such notice) in the event of the Contractor failing to comply with any such requisition, the Engineer-In-Charge may remove them at the Contractor's expense or sell them by auction or private sale on account of the Contractor and his risk in all respects and the certificate of the Engineer-In-Charge as to the expenses of any such removal and the amount of the proceeds and expenses of any such sale shall be final and conclusive against the Contractor.

72.4 TIME ESSENCE OF CONTRACT & EXTENSION FOR DELAY

The time allowed for execution of the Works as specified in the terms of contract or the extended time in accordance with these conditions shall be the essence of the contract. The execution of the works shall commence from the 10th Day or such time period as mentioned in letter of Intent after the date on which the Engineer-In-Charge issues written orders to commence the work. If the Contractor commits default in commencing the execution of the work as aforesaid, the Executing Agency shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the earnest money absolutely.

72.4.1 Within 10 (Ten) days of Letter of Intent, the Contractor shall submit a Time and Progress Chart (CPM/PERT/ Quantified Bar Chart) and get it approved by the Engineer-In-Charge. The Chart shall be prepared in direct relation to the time stated in the contract documents for completion of items of the works. It shall indicate the forecast (mile-stones) of the dates of commencement and completion of various items, trades, sections of the work and may be amended as necessary by agreement between the Engineer-In-Charge and the Contractor within the limitations of time stipulated in the Contract documents, and further to ensure good progress during the execution of the work, the Contractor shall in all cases in which the time allowed for any work exceeds one month (save for
special jobs for which a separate program has been agreed upon) complete 1/8th of the whole of work before 1/4th of the whole time allowed in the contract has elapsed, 3/8th of the work before one half of such time has elapsed and 3/4th of the work before 3/4th of such time has elapsed. The physical report including photographs shall be submitted by the Contractor on the prescribed format & the intervals (not exceeding a month) as decided by the Engineer in Charge. The compensation for delay as per clause 72.1 shall be leviable at intermediate stages also, in case the required progress is not achieved to meet the above time deadlines of the completion period and/ or milestones of time and progress chart, provided always that the total amount of Compensation for delay to be paid under this condition shall not exceed 10% (Ten Percent) of the tendered value of work”.

72.4.2 If the work(s) be delayed by:

i) force-majeure or
ii) abnormally bad weather, or
iii) serious loss or damage by fire, or
iv) civil commotion of workmen, strike or lockout, affecting any or the trades employed on the work, or
v) delay on the part of other Contractors or tradesmen engaged by Engineer-In-Charge in executing work not forming part of the Contract, or
vi) non-availability of stores, which are responsibility of EPI or,
vii) non-availability or break down of tools and plant to be supplied or supplied by EPI or,
viii) any other cause which, in the absolute discretion of EPI, is beyond the Contractor’s control,

then, upon the happening of any such event causing delay, the Contractor shall immediately give notice thereof in writing to the Engineer-In-Charge but shall nevertheless use constantly his best endeavors to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-In-Charge to proceed with the works.

72.4.3 Request for extension of time, to be eligible for consideration, shall be made by the Contractor in writing within fourteen days of the happening of the event causing delay on the prescribed form. The Contractor may also, if practicable, indicate in such a request the period for which extension is desired. In any such case EPI may give a fair and reasonable extension of time for completion of work. Such extension shall be communicated to the Contractor by the Engineer-In-Charge in writing, within 3 months of the date of receipt of such request. Non-application by the Contractor for extension of time shall not be a bar for giving a fair and reasonable extension by the Engineer-In-Charge and the extension of time so given by the Engineer-In-Charge shall be binding on the Contractor.

73.0 WITHHOLDING AND LIEN IN RESPECT OF SUMS DUE FROM CONTRACTOR

73.1 Whenever any claim or claims for payment of a sum of money arises out of or under the contract or against the Contractor, EPI shall be entitled to withhold and also have a lien to retain such sum or sums in whole or in part from the security,
if any, deposited by the Contractor and for the purpose aforesaid, EPI shall be entitled to withhold the Retention Money, if any, furnished as the case may be and also have a lien over the same pending finalization or adjudication of any such claim. In the event of the security being insufficient to cover the claimed amount or amounts or if no security has been taken from the Contractor, EPI shall be entitled to withhold and have a lien to retain to the extent of such claimed amount or amounts referred to above, from any sum or sums found payable or which may at any time thereafter become payable to the Contractor under the same contract or any other contracts pending finalization or adjudication of any such claim.

73.2 It is an agreed term of the contract that the sum of money or moneys so withheld or retained under the lien referred to above by the Engineer-In-Charge or EPI will be kept withheld or retained as such by the Engineer-In-Charge or EPI till the claim arising out of or under the contract is determined by the Arbitrator / Competent Court and that the Contractor will have no claim for interest or damages whatsoever on any account in respect of such withholding or retention under the lien referred to above and duly notified as such to the Contractor. For the purpose of this clause, where the Contractor is a sole proprietor or a partnership firm or a limited company, etc. the Engineer-In-Charge or EPI shall be entitled to withhold and also have a lien to retain towards such claimed amount or amounts in whole or in part from any sum found payable to proprietor /partnership firm/limited company, as the case may be whether in his individual capacity or otherwise.

EPI shall have the right to cause an audit and technical examination of the works and the final bills of the Contractor including all supporting vouchers, abstract, etc, to be made after payment of the final bill and if as a result of such audit and technical examination any sum is found to have been overpaid in respect of any work done by the Contractor under the contract or any work claimed to have been done by him under the contract and found not to have been executed, the Contractor shall be liable to refund the amount of over-payment and it shall be lawful for EPI to recover the same from him in the manner prescribed in sub-clause (I) of this clause or in any other manner legally permissible; and if it is found that the Contractor was paid less than what was due to him under the contract in respect of any work executed by him under it, the amount of such under payment shall be duly paid by EPI to the Contractor, without any interest thereon whatsoever.

73.3 LIEN IN RESPECT OF CLAIMS IN OTHER CONTRACTS

Any sum of money due and payable to the Contractor (including the Retention Money & Security deposit returnable to him) under the contract may be withheld or retained by way of lien by the Engineer-In-Charge or by EPI against any claim of the Engineer-In-Charge or EPI in respect of payment of a sum of money arising out of or under any other contract made by the Contractor with the Engineer-In-Charge or EPI.

It is an agreed term of the contract that the sum of money so withheld or retained under this clause by the Engineer-In-Charge or EPI will be kept withheld or retained as such by the Engineer-In-Charge or EPI or till his claim arising out of the same contract or any other contract is either mutually settled or determined by the Arbitrator or Competent Court as the case may be, and that the Contractor shall have no claim for interest or damages whatsoever on this account or on any
other ground in respect of any sum of money withheld or retained under this clause and duly notified as such to the Contractor.

74.0  DEFECTS LIABILITY PERIOD

The Contractor shall be responsible for the rectification of defects in the works for a period of twelve months from the date of taking over of the works by the Owner/ Client. Any defects discovered and brought to the notice of the Contractor forthwith shall be attended to and rectified by him at his own cost and expense. In case the Contractor fails to carry out these rectifications, the same may without prejudice to any other right or remedy available, be got rectified by EPI at the cost and expense of the Contractor.

75.0  FORCE MAJEURE

Any delay or failure of the performance of either party hereto shall not constitute default hereunder to give rise to any claims for damages, if any to the Extent such delay or failure of performance is caused by occurrences such as Acts of God or the public enemy, expropriation, compliance with any order or request of Government authorities/ Courts, acts of war, rebellions, sabotage fire, floods, illegal strikes, or riots (other than Contractor's employees). Only extension of time shall be considered for Force Majeure conditions as accepted by EPI. No adjustment in contract price shall be allowed for reasons of force majeure.

76.0  ARBITRATION

76.1 Before resorting to arbitration as per the clause given below, the parties if they so agree may explore the possibility of conciliation as per the provisions of Part-III of the Arbitration and Conciliation Act. 1996. When such conciliation has failed, the parties shall adopt the following procedure for arbitration:

i) Except where otherwise provided for in the contract, any disputes and differences relating to the meaning of the Specifications, Design, Drawings and Instructions herein before mentioned and as to the quality of workmanship or materials used in the work or as to any other question, claim, right, matter or thing whatsoever in any way arising out of or relating to the Contract, Designs, Drawings, Specifications, Estimates, Instructions, or these conditions, or otherwise concerning the works or the execution or failure to execute the same whether arising during the progress of the work or after the completion or abandonment thereof shall be referred to the Sole Arbitration of the Chairman and Managing Director (CMD) of Engineering Projects (India) Limited (EPI), or any other person discharging the functions of CMD of EPI and if CMD or such person discharging the functions of CMD of EPI is unable to act, to the sole Arbitration of some other person appointed by CMD of EPI or such other person discharging the functions of CMD of EPI. There will be no objection if the arbitrator so appointed is an employee of Engineering Projects (I) Ltd. However, such an employee shall not have directly dealt with the said Contract or the works there under on behalf of EPI. Such Arbitrator shall be appointed within 30 days of the receipt of letter of invocation of arbitration duly satisfying the requirements of this clause.
ii) If the arbitrator so appointed resigns or is unable or unwilling to act due to any reason whatsoever, or dies, the Chairman & Managing Director aforesaid or in his absence the person discharging the duties of the CMD of EPI may appoint a new arbitrator in accordance with these terms and conditions of the contract, to act in his place and the new arbitrator so appointed may proceed from the stage at which it was left by his predecessor.

iii) It is a term of the contract that the party invoking the arbitration shall specify the dispute / differences or questions to be referred to the Arbitrator under this clause together with the amounts claimed in respect of each dispute.

iv) The Arbitrator may proceed with the arbitration ex-parte, if either party, in spite of a notice from the arbitrator, fails to take part in the proceedings.

v) The work under the contract shall continue as directed by the Engineer-In-Charge, during the arbitration proceedings.

vi) Unless otherwise agreed, the venue of arbitration proceedings shall be at the venue given in the ‘Memorandum’ to the ‘Form of Tender’.

vii) The award of the Arbitrator shall be final, conclusive and binding on both the parties.

viii) Subject to the aforesaid, the provisions of the Arbitration and Conciliation Act, 1996 or any statutory modifications or re-enactment thereof and the Rules made thereunder and for the time being in force shall apply to the arbitration proceedings and Arbitrator shall publish his Award accordingly.

NOTE

NOTWITHSTANDING ANYTHING CONTAINED HEREINABOVE, THIS CLAUSE SHALL NOT BE APPLICABLE WHERE THE DISPUTE IS BETWEEN EPI AND ANOTHER CENTRAL PUBLIC SECTOR ENTERPRISE OR GOVT. OF INDIA DEPARTMENT, FOR WHICH A SEPARATE ARBITRATION CLAUSE IS PROVIDED VIDE CLAUSE NO. 76.2 GIVEN BELOW:

76.2 ARBITRATION BETWEEN CENTRAL PUBLIC SECTOR ENTERPRISES INTER SE / GOVERNMENT OF INDIA DEPARTMENTS/ MINISTRIES

i) In the event of any dispute or difference relating to the interpretation and application of the provisions of the contract, such dispute or difference shall be referred by either party to the arbitration as per the instructions (Office Memorandums / Circulars) issued by Govt. of India from time to time with regard to arbitration between one Government Department and another, one Government Department and a Public Sector Enterprise and Public Sector Enterprise inter se.

ii). Subject to any amendment that may be carried out by the Government of India from to time, the procedure to be followed in the arbitration shall be as is
contained in D.O. No. DPE/4(10)/2001-PMA-GL-I dated 22.01.2004 of Department of Public Enterprises, Ministry of Heavy Industries and Public Enterprises, Government of India or any modification issued in this regard.

76.3 JURISDICTION

The courts mentioned in the ‘Memorandum’ to the ‘Form of Tender’ alone will have jurisdiction to deal with matters arising from the contract, to the exclusion of all other courts.

77.0 SUSPENSION OF WORKS

(a) The Contractor shall, on receipt of the order in writing of the Engineer-In-Charge, suspend the progress of the works or any part thereof for such time and in such manner, as the Engineer-In-Charge may consider necessary for any of the following reasons:

i) On account of any default on part of the Contractor, or

ii) For proper execution of the works or part thereof for reason other than the default of the Contractor, or

iii) For safety of the works or part thereof.

The Contractor shall, during such suspension, properly protect and secure the works to the extent necessary and carry out the instructions given in that behalf by the Engineer-In-Charge.

(b) If the suspension is ordered for reasons (ii) and (iii) in sub-para (a) above, the Contractor shall be entitled to an extension of the time equal to the period of every such suspension plus 25%. No adjustment of contract price will be allowed for reasons of such suspension.

(c) In the event of the Contractor treating the suspension as an abandonment of the contract by EPI, he shall have no claim to payment of any compensation on account of any profit or advantage which he may have derived from the execution of the work in full but which he could not derive in consequence of the abandonment.

(d) The Contractor shall resume work in all earnestness after suspension has been lifted by EPI.

78.0 TERMINATION OF CONTRACT ON DEATH OF CONTRACTOR

If the Contractor is an individual or a proprietorship concern and the individual or the proprietor dies then unless the Engineer-In-Charge is satisfied that the legal representatives of the individual Contractor or of the proprietor of the proprietary concern and in the case of partnership firm, the surviving partners, are capable of carrying out and completing the contract, the Engineer-In-Charge shall be entitled to cancel the contract as to its incompleted part without EPI being in any
way liable to payment of any compensation to the estate of the deceased Contractor and/or to surviving partners of the Contractor's firm on account of cancellation of the contract. Such cancellation of Contract shall be with out prejudice to any of the rights & remedies available to the Engineer-In-Charge under the contract. The decision of the Engineer-In-Charge that the legal representatives of the deceased Contractor or the surviving partners of the Contractor's firm cannot carry out and complete the contract shall be final and binding on the parties.

79.0 CLARIFICATION AFTER TENDER SUBMISSION

Tenderer’s attention is drawn to the fact that during the period, the bids are under consideration, the bidders are advised to refrain from contacting by any means, EPI and/or his employees/ representatives on matters related to the bid under consideration and that if necessary, EPI will obtain clarifications in writing or as may be necessary. The Tender evaluation and process of award of works is done by duly authorized Tender Scrutiny Committee and this committee is authorized to discuss and get clarification from the tenderers.

80.0 ADDENDA/ CORRIGENDA

Addenda/Corrigenda to the Tender Documents may be issued prior to the date of opening of the Tender to clarify or effect modification in specification and/or contract terms included in various Tender Documents. The tenderer shall suitably take into consideration such Addenda/Corrigenda while submitting his tender. The tenderer shall return such Addenda/ Corrigenda duly signed and stamped as confirmation of its receipt and submit alongwith the Tender Document. All Addenda/ Corrigenda shall be signed and stamped on each page by the tenderer and shall become part of the Tender and contract documents.

81.0 QUALITY ASSURANCE PROGRAMME

To ensure that the works/services under the scope of this contract are in accordance with the specifications, the Contractor shall adopt Quality Assurance Programme to control such activities at the necessary points. The Contractor shall prepare and finalize such Quality Assurance Programme within 15 days from letter of intent. EPI shall also carryout quality audit and quality surveillance of systems and procedures of Contractor’s quality control activities. A Quality Assurance Programme of Contractor shall generally cover the following:

a) His organization structure for the management and implementation of the proposed Quality Assurance Program.
b) Documentation control system.
c) The procedure for procurement of materials and source inspection.
d) System for site controls including process controls.
e) Control of non-conforming items and systems for corrective actions.
f) Inspection and test procedure for site activities.
g) System for indication and appraisal of inspection status.
h) System for maintenance of records.
i) System for handling, storage and delivery.
j) A quality plan detailing out quality practices and procedures, relevant standards and acceptance levels for all types of work under the scope of this contract.

All the quality reports shall be submitted by the Contractors in the formats appended hereto. Checklist enclosed here in this document shall be followed while carrying out Construction activities (items). If any item is not covered by the Checklist/ Formats appended hereto, the Format for the same may be developed and submitted to Engineer-In-Charge for approval and the same shall be adopted. These filled in formats shall be prepared in two copies and duly signed by representatives of Contractor and EPI. All the costs associated with printing of Formats and testing of materials required as per technical specifications or by Engineer-In-Charge shall deemed to be included in the Contractor’s quoted rates of various items of work in the Schedule/ Bill of Quantities.

82.0 APPROVAL OF TEMPORARY / ENABLING WORKS

The setting and nature of all offices, huts, access road to the work areas, and all other temporary works as may be required for the proper execution of the works shall be subject to the approval of the Engineer-In-Charge.

All the equipments, labour, material including cement, reinforcement and the structural steel required for the enabling/ temporary works associated with the entire Contract shall have to be arranged by the Contractor only. Nothing extra shall be paid to the Contractor on this account and the unit rates quoted by the Contractor for various items in the Bill of Quantities shall be deemed to include the cost of enabling works.

83.0 CONTRACT COORDINATION PROCEDURES, COORDINATION MEETINGS AND PROGRESS REPORTING

The Contractor shall prepare and finalize in consultation with EPI, a detailed contract coordination procedure within 15 days from the date of issue of Letter of Intent for the purpose of execution of the Contract.

The Contractor shall have to attend all the meetings at any place in India at his own cost with EPI, Owners/ Clients or Consultants of EPI/ Owner/ Client during the currency of the Contract, as and when required and fully cooperate with such persons and agencies involved during these discussions. The Contractor shall not deal in any way directly with the Clients/ Owners or Consultants of EPI/ Owner/ Clients and any dealing/ correspondence if required at any time with Clients/ Owners/ Consultants shall be through EPI only.

During the execution of the work, Contractor shall submit at his own cost detailed Monthly progress report to the Engineer-In-Charge of EPI by 5th of every month. The format of monthly progress report shall be as approved by Engineer-In-Charge of EPI.

84.0 CONTRACT AGREEMENT
The Contractor shall enter into a Contract Agreement with EPI within 10 days of the date of Letter of Intent or within such extended time, as may be granted by EPI. The cost of stamp papers, stamp duty, registration, if applicable on the contract, shall be borne by the Contractor. In case, the Contractor does not sign the agreement as above or does not start the work within 10 days of the issue of letter/telegram of intent, his earnest money is liable to be forfeited and letter of intent consequently will stand withdrawn.

85.0 MANNER OF EXECUTION OF AGREEMENT

i. The agreement as per prescribed Performa as enclosed to the Additional Conditions of Contract shall be signed at the office of EPI within 10 days from the date of issue of Letter of Intent. The Contractor shall provide for signing of the Contract, appropriate Power of Attorney in favour of the authorised representative duly attested by notary Public and the requisite documents/materials. Till a formal contract is prepared and executed, the Letter of Intent read in conjunction with the Bidding Documents will constitute a binding contract.

ii. The agreement will be signed in two originals and three more copies, EPI shall retain the ‘Original’, the Contractor shall be provided with the other signed original and the remaining three copies will be retained by EPI. In case of a dispute of any kind whatsoever, the ‘Original” retained by EPI alone shall be treated as the ‘Original Agreement’.

iii. The Contractor shall provide free of cost to EPI all the Engineering data, drawings and descriptive materials submitted along with the bid, in at least five (5) copies to form an integral part of the Agreement within seven 7 days after issuing of Letter of Intent.

iv. Subsequent to signing of the Agreement, the Contractor at his own cost shall provide to EPI with at least five (5) true hard bound copies of Agreement alongwith all the enclosures viz. letter of intent, Tender Documents etc. within thirty (30) days of its signing.

86.0 PURCHASE PREFERENCE TO PUBLIC SECTOR ENTERPRISES

EPI reserves its right to extend Purchase Preference to Central Public Sector Enterprises (CPSEs) as per policy of Government of India, if any, as applicable on this work. The tenderers are requested to go through latest instructions of Government of India on its Purchase Preference Policy for CPSEs before quoting for the Tender.

87.0 CHANGE IN FIRM’S CONSTITUTION TO BE INTIMATED

Where the Contractor is a partnership firm, prior approval in writing of EPI shall be obtained before any change is made in the constitution of the firm. Where the Contractor is an individual or a Hindu undivided family business concern such approval as aforesaid shall likewise be obtained before the Contractor enters into any partnership agreement whereunder the partnership firm would have the right to carry out the works hereby undertaken by the Contractor. If prior approval as aforesaid is not obtained, the contract shall be deemed to have been assigned in
contravention of Clause 59.1 hereof and EPI shall be entitled to take action under Clause 72.2 (xi).

88.0 COMPLIANCE WITH ISO PROCEDURES

EPI is an ISO-9001 and ISO-14001 Company. The conditions of the ISO as applicable shall be followed by the Contractor for implementation & maintaining the established procedures of EPI.
LABOUR SAFETY PROVISIONS

1.0 Suitable scaffolds should be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1/4 to 1 (1/4 horizontal and 1 vertical).

2.0 Scaffolding or staging more than 3.6m (12 feet) above the ground or floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly attached or bolted, braced and otherwise secured at least 90 cm. (3 feet) high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

3.0 Working platforms, gangways, and stairways should be so constructed that they should not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.6m (12 feet) above ground level or floor level, they should be closely boarded, should have adequate width & should be suitable fastened as described in (2.0) above.

4.0 Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm (3 feet).

5.0 Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9m. (30 feet) in length while the width between side rails in rung ladder shall in no case be less than 29 cm. for ladder up to and including 3m (10 feet) in length. For longer ladders this width should be increased at least 1/4" for each additional 30 cm (1 ft.) of length. Uniform step spacing shall not exceed 30 cm (12"). Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites of the work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The Contractor shall provide all necessary fencing and lights to protect the public from accident, and shall be bound to bear the expenses of defence of every suit, action or other proceeding at law that may be brought by an person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit, action or proceedings to any such person or which may, with the consent of the Contractor, be paid to compensate any claim by any such person.

6.0 EXCAVATION AND TRENCHING

All trenches, 1.2mts.(four feet) or more in depth, shall at all times be supplied with at least one ladder for each 30m. (100 feet) in length or fraction thereof, Ladder shall be extended from bottom of the trench to at least 90 cm (3feet) above the surface of the ground. The sides of the trenches, which are 1.5m. (5feet) or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger or sides to collapsing. The excavated materials shall not be placed within 1.5m (5 feet) of the edges of the
trench or half of the depth of the trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

7.0 Demolition - Before any demolition work is commenced and also during the progress of the work:

7.1 All roads and open areas adjacent to the work Site shall either be closed or suitably protected.

7.2 No electric cable or apparatus which is likely to be a source of danger or a cable or apparatus used by the operator shall remain electrically charged.

7.3 All practical steps shall be taken to prevent danger to persons employed from risk or fire or explosion or flooding. No floor, roof or other part of the building shall be overloaded with debris or materials as to render it unsafe.

8.0 All necessary personal safety equipments as considered adequate by the Engineer-In-Charge should be kept available for the use of persons employed on the Site and maintained in a condition suitable for immediate use, and the Contractor should take adequate step to ensure proper use of equipment by those concerned- The following safety equipment shall be invariably provided.

8.1 Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective goggles.

8.2 Those engaged in white washing and mixing or stacking of cement bags or any materials which are injurious to the eye shall be provided with protective goggles.

8.3 Those engaged in welding works shall be provided with welder’s protective eye shields.

8.4 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe interval.

8.5 When workers are employed in sewers and manholes, which are in active use, the Contractors shall ensure that the manhole covers are opened and ventilated at-least for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident the public. In addition, the Contractor shall ensure that the following safety measures are adhered to:

a. Entry for workers into the line shall not be allowed except under supervision of the JE or any other higher officer.

b. At least 5 to 6 manholes upstream and down stream should be kept open for at least 2 to 3 hours before any man is allowed to enter into the manholes for working inside.

c. Before entry, presence of Toxic gases should be tested by inserting wet lead acetate paper which changes colour in the presence of such gases and gives indication of their presence.

d. Presence of Oxygen should be verified by lowering a detector lamp into the manhole. In case, no Oxygen is found inside the sewer line, workers should be sent only with Oxygen kit.
e. Safety belt with rope should be provided to the workers. While working inside the manholes such rope should be handled by two men standing outside to enable him to be pulled out during emergency.

f. The area should be barricaded or cordoned of by suitable means to avoid mishaps of any kind. Proper warning signs should be displayed for the safety of the public whenever cleaning works are undertaken during night or day.

g. No smoking or open flames shall be allowed near the blocked manhole being cleaned.

h. The malba obtained on account of cleaning of blocked manholes and sewer lines should be immediately removed to avoid accidents on account of slippery nature of the malba.

i. Workers should not be allowed to work inside the manhole continuously. He should be given rest intermittently. The Engineer In-charge may decide the time up to which a worker may be allowed to work continuously inside the manhole.

j. Gas masks with Oxygen Cylinder should be kept at Site for use in emergency.

k. Air-blowers should be used for flow of fresh air through the manholes. Whenever called for, portable air-blowers are recommended for ventilating the manholes. The Motors for these shall be vapour proof and of totally enclosed type. Non-sparking gas engines also could be used but they should be placed at-least 2 meters away from the opening and on the leeward side protected from wind so that they will not be a source of friction on any inflammable gas that might be present.

l. The workers engaged for cleaning the manholes/ sewers should be properly trained before allowing them to work in the manhole. m. The workers shall be provided with Gumboots or non-sparking shoes, bump helmets and gloves non-sparking tools, safety lights and gas masks and portable air blowers (when necessary). They must be supplied with barrier cream for anointing the limbs before working inside the sewer lines.

n. Workmen descending a manhole shall try each ladder step or rung carefully before putting his full weight on it to guard against insecure fastening due to corrosion of the rung fixed to manhole well.

o. If a man has received a physical injury, he should be brought out of the sewer immediately and adequate medical aid should be provided to him.

p. The extent to which these precautions are to be taken depend on individual situation but the decision of the Engineer-In-Charge regarding the steps to be taken in this regard in an individual case will be final.

8.6 The Contractor shall not employ men and women below the age of 18 years on the work of painting with products containing lead in any form Wherever men above the age of 18 are employed on the work of lead painting the following precautions should be taken.

8.6.1 No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

8.6.2 Suitable facemasks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scrapped.
8.6.3 Overalls shall be supplied by the Contractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

8.6.4.1 a. White lead, sulphate or lead work products containing those pigments shall not be used in painting operation except in the form of paste or of paints ready for use.

b. Measures shall be taken whenever required in order to prevent danger arising from the application of paint in the form of spray.

c. Measures shall be taken, whenever practicable to prevent danger arising out of dust caused by dry rubbing down and scraping.

8.6.4.2 a. Adequate facilities shall be provided to enable working painter to wash during and on cessation of work.

b. Suitable arrangements shall be made to prevent clothing put off during working hours being spoiled by painting materials.

8.6.4.3 a) Cases of lead poisoning and of suspected lead poisoning shall be notified and shall be subsequently verified by a medical man appointed by the competent authorities of the Consultant.

b) EPI may require when necessary a medical examination of workers.

c) Instructions with regard to the special hygienic precautions to be taken in the painting trade shall be distributed to working painters.

9.0 When the work is done near any place where there is risk of drowning, all necessary equipments should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions should be made for prompt first aid treatment of all injuries likely to be obtained during the course of the work.

10.0 Use of hoisting machines and tackle including their attachment encourage and supports shall conform to the following standard of conditions.

10.1 a. These shall be of good mechanical construction, sound material and adequate strength and free from patent, defects and shall be kept required in good working order.

b) Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent defects.

10.2 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in-charge of any hoisting machine including any scaffolding, winch or giving signals to operator.
10.3 In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or as means of suspension the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

10.4 In case of EPI machines, the safe working load shall be notified by the Engineer-In-Charge. As regards Contractor’s machines the Contractor shall notify the safe working load of the machine to the Engineer-In-Charge whenever he brings any machinery to Site of work and get verified by the Engineer-In-Charge.

11.0 Motors gearing, transmission electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safeguard, hosting appliances should be provided with such means as will reduce to the minimum the risk of accidental descent of the load. Adequate precautions should be taken to reduce the minimum the risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations, which are already energized, insulating mats, wearing apparel, such as gloves sleeves and boots as may be necessary, be provided. The worker should not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.

12.0 All scaffold, ladders, and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near places of work.

13.0 These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place of work spot. The person responsible for compliance of the safety codes shall be named therein by the Contractor.

14.0 To ensure effective enforcement of the rules and regulations relating to safety precautions the arrangements made by the Contractor shall be open to inspection by the or their representatives.

15.0 Notwithstanding the above Clauses from (i) to (xiv) there is nothing in these to exempt the Contractor from the operations of any other Act or Rule in force in the Republic of India.
MODEL RULES FOR THE PROTECTION OF HEALTH AND SANITARY ARRANGEMENTS FOR WORKERS

1.0 APPLICATION

These rules shall apply to all building and construction works in which 20 (twenty) or more workers are ordinarily employed or are proposed to be employed in any day during the period during which the Contractor work is in progress.

2.0 DEFINITION

Work place means a place where twenty or more workers are ordinarily employed or are proposed to be employed in connection with construction work on any day during the period during which the Contractor work is in progress.

3.0 FIRST-AID FACILITIES

3.1 At every work place first aid facilities shall be provided and maintained, so as to be easily accessible during working hours, First-Aid boxes at the rate of not less than one box per 150 contract labour or part thereof ordinarily employed.

3.2 The First-Aid box shall be distinctly marked with a red cross on white ground and shall contain the following equipments:-

3.2.1 a) For work places in which number of contract labour employed does not exceed 50, Each First-Aid box shall contain the following equipments:

i) 6 small sterilized dressings.

ii) 3 medium size sterilized dressings.

iii) large size sterilized dressings.

iv) 3 large sterilized burn dressings.

v) 1 (30 ml) bottle containing a two percent alcoholic solution of iodine.

vi) 1(30 ml) bottle containing salvolatile having the dose and mode of administration indicated on the label.

vii) 1 snake-bite lancet.

viii) 1 (30 gms) bottle of potassium permanganate crystals.

ix) 1 pair of scissors.

x) 1 copy of the First-Aid leaf-let issued by the Director General, Factory Advise Service & Labour Institutes, Government of India.

xi) 1 bottle containing 100 tablets (each of 5 grams) of aspirin.

xii) Ointment for burns.

xiii) A bottle of suitable surgical antiseptic solution.
3.2.2 For work places in which the number of contract labour exceed 50. Each First-Aid box shall contain the following equipments:

i) 12 small sterilized dressings.
ii) 6 medium size sterilized dressings.
iii) 6 large size sterilized dressings.
iv) 6 large size sterilized burn dressings.
v) 6 (15 gms) packet sterilized cotton wool.
vi) 1 (60 ml.) bottle containing a two percent iodine alcoholic solution.
vii) 1 (60 ml.) bottle containing salvolatile having the dose and mode of administration indicated on the label.
viii) 1 roll of adhesive plaster.
ix) 1 snake – bite lancet.
x) 1 (30 gms.) bottle of potassium permanganate crystals.
xi) 1 pair of scissors.
xii) 1 copy of the First-Aid leaf-let issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
xiii) A bottle containing 100 tablets (each of 5 grams) of aspirin.
xiv) Ointment for burns.
xv) A bottle of suitable surgical antiseptic solution.

3.3 Adequate arrangements shall be made for immediate recoupment of the equipment when necessary.

3.4 Nothing except the prescribed contents shall be kept in the First Aid box.

3.5 The First Aid box shall be kept in charge of a responsible person who shall always be readily available during the working hours of the work place.

3.6 A person in charge of the First-Aid box shall be a person trained in First-Aid treatment, in work places where the number of labour employed is 150 or more.

3.7 In work places where the number of labour employed is 500 or more and hospital facilities are not available within easy distance of the works, first-Aid Posts shall be established and run by a trained Compounder. The Compounder shall be on duty and shall be available at all hours when the workers are at work.

3.8 Where work places are situated in places, which are not towns of cities, a suitable motor transport shall be kept readily available to carry injured person or persons suddenly taken ill to the nearest hospital.

4.0 DRINKING WATER

4.1 In every work place, there shall be provided and maintained at suitable places, easily accessible to labour, a sufficient supply of cold water fit for drinking.

4.2 Where drinking water is obtained from an intermittent public water supply, each work place shall be provided with storage where such drinking water shall be stored.

4.3 Every water supply of storage shall be at a distance of not less than 50 feet from any latrines drain or other source of pollution, Where water has to be drawn from
an existing well which is within such proximity of latrine, drain or any other source of pollution, the well shall be properly chlorinated before water is drawn from it for drinking. All such wells shall be entirely closed in and be provided with a trap-door which shall be dust and waterproof.

4.4 A reliable pump shall be fitted to each covered well, trap-door shall be kept locked and opened only for cleaning or inspection which shall be done at least once a month.

5.0 WASHING FACILITIES

5.1 In every work place adequate and suitable facilities for washing shall be provided and maintained for the use of labour employed herein.

5.2 Separate and adequate screening facilities shall be provided for the use of male and female workers.

5.3 Such facilities shall be conveniently accessible and shall be kept clean and hygienic condition.

6.0 LATRINES AND URINALS

6.1 Latrines shall be provided in every work place on the following scale, namely:

   a) Where females are employed there shall be at least one latrine for every 25 females.

   b) Where males are employed, there shall be at least one latrine for every 25 males.

Provided that where the number of males or females exceeds 100, it shall be sufficient if there is one latrine for 25 males or females, as the case may be, up to the first 100, and one for every 50 thereafter.

6.2 Every latrine shall be under cover and so partitioned off as to secure privacy, and shall has a proper door and fastenings.

6.3 Construction of Latrines: The inside walls shall be constructed of masonry or some suitable heat resisting non-absorbent materials and shall be cement washed inside and outside at least once a year. Latrine shall not be a standard lower than borehole system.

6.4 (a) Where workers of both sexes are employed, there shall be displayed outside each block of latrine and urinal, a notice in the language understood by the majority of the workers “For Men only” or “For Women only” as the case may be.

   (b) The notice shall also bear the figure of man or of a women, as the case may be.
6.5 There shall be at least one urinal for male workers up to 50 and one for female workers up to 50 employed at a time. Provided that where the number of male or female workmen, as the case may be, exceeds 500, it shall be sufficient if there is one urinal for every 50 males or females up to the first 500 and one for every 100 or part thereof, thereafter.

6.6 a) The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.

   b) Latrines and urinals other than those connected with a flush sewerage system shall comply with the requirements of the Public Health Authorities.

6.7 Water shall be provided by means of a tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.

6.8 DISPOSAL OF EXCRETA

Unless otherwise arranged for by the local sanitary authority arrangements for proper disposal of excreta by incineration at the work place shall be made by means of a suitable incinerator. Alternatively excreta may be disposed off by putting a layer of night soil at the bottom of a pucca tank prepared for the purpose and covering it with a 15 cm layer of waste or for refuse and then covering it with a layer of earth for fortnight (when it will turn into manure).

6.9 The Contractor shall, at his own expense, carry out all instruction issued to him by the Engineer-In-Charge to effect proper disposal of night soil and other conservancy work in respect of the Contractor’s workmen or employees on the Site. The Contractor shall be responsible for payment of any charges, which may be levied by Municipal or Cantonment Authority for execution of such work on his behalf.

7.0 PROVISION OF SHELTER DURING REST

At every place there shall be provided, free of cost four suitable sheds, two for males and the other two for rest separately for the use of man and women labour. The height of each shelter shall not be less than 3 meters from the floor level to the lowest part of the roof. These shall be kept clean and the space provided shall be on the basis of 0.6 sqm. Per head.

Provided that the Engineer-In-Charges may permit, subject to his satisfaction, a portion of the building under construction or other alternative accommodation to be used for the purpose.

8.0 CRECHES

8.1 A every work place, at which 20 or more women workers are ordinarily employed, there shall be provided two rooms of reasonable dimensions for the use of their children under the age of six years. One room shall be used as a playroom for the children and the other as their bedrooms.

The rooms shall be constructed on standard not lower than the following:
8.2 The rooms shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean.

8.3 The Contractor shall supply adequate number of toys and games in the playroom and sufficient number of cots and beddings in the bedroom.

8.4 The Contractor shall provide one Ayaa to look after the children in the creche when the number of women workers does not exceed 50 and two when the number of women workers exceed 50.

8.5 The use of the rooms/earmarked as ealize shall be restricted to children, their attendant and mother of the children.

9.0 CANTEENS

9.1 In every work place where the work regarding the employment of contract labour is likely to continue for six months and wherein contract labour numbering one hundred or more are ordinarily employed, an adequate canteen shall be provided by the Contractor for the use of such labour.

9.2 The canteen shall be maintained by the Contractor in an efficient manner.

9.3 The canteen shall consist of at least a dining hall, kitchen, storeroom, pantry and washing places separately for workers and utensils.

9.4 The canteen shall be sufficiently lighted at all times when any person has access to it.

9.5 The floor shall be made of smooth and impervious material and inside walls shall be lime washed or colour washed at least once in each year.

Provided that the inside walls of the kitchen shall be lime-washed every four months.

9.6 The premises of the canteen shall be maintained in a clean and sanitary condition.

9.7 Waste Water shall be carried away in suitable covered drains and shall not be allowed to accumulate so as to cause a nuisance.

9.8 Suitable arrangements shall be made for the collection and disposal of garbage.

9.9 The dining hall shall accommodate at a time 30 persons of the labour working at time.
9.10 The floor area of the dining hall, excluding the area occupied by the service counter and any furniture except tables and chairs shall not be less than one square meter per dinner to be accommodated.

9.11 a) A portion of the dining hall and service counter shall be partitioned off and reserved for women workers in proportion to their number.

b) Washing places for women shall be separate and screened to secure privacy.

9.12 Sufficient tables, stools, chairs or benches shall be available for the number of dinners to be accommodated.

9.13.1 a) There shall be provided and maintained sufficient utensils, crockery, furniture and any other equipment necessary for the efficient running of the canteen.

b) The furniture, utensils and other equipment shall be maintained in a clean and hygienic condition.

9.13.2 a) Suitable clean clothes for the employees serving in the canteen shall be provided and maintained.

b) A service counter, if provided, shall have top of smooth and impervious material.

c) Suitable facilities including an adequate supply of hot water shall be provided for the cleaning of utensils and equipment.

9.14 The foodstuffs and other items to be served in the canteen shall be in conformity with the normal habits of the labour.

9.15 The charge for foodstuffs, beverages and any other items served in the canteen shall be based on ‘No profit No loss’ and shall be conspicuously displayed in the canteen.

9.16 In arriving at price of foodstuffs and other articles served in the canteen, the following items shall not be taken into consideration as expenditure, namely:

a) The rent of land building.

b) The depreciation and maintenance charges for the building and equipment provided for the canteen.

c) The cost of purchase, repair and replacement of equipment including furniture, crockery, cutlery and utensils:

d) The water charges and other charges incurred for lighting and ventilation:

e) The interest and amounts spent on the provision and maintenance and equipment provided for in the canteen.
9.17 The accounts pertaining to the canteen shall be audited once every 12 months by registered accountants and auditors.

10.0 ANTI MALARIAL PRECAUTIONS

The Contractor shall at his own expense, conform to all anti-malarial instructions given to him by the Engineer-In-Charge including the filling up of any borrow pits which may have been dug by him.

11.0 AMENDMENTS

EPI may from time to time, add to or amend these rules and issue such directions as it may consider necessary for the purpose of removing any difficulty which may arise in the administration hereof.
CONTRACTOR’S LABOUR REGULATIONS

1.0 SHORT TITLE

These regulations may be called the Contractor “Labour Regulations”.

2.0 DEFINITIONS

2.1 “Workman” means any person employed by EPI or its Contractor directly or indirectly through a sub-Contractor, with or without the knowledge, of EPI to do any skilled, semi-skilled, unskilled, manual, supervisory, technical or clerical work for hire or reward, whether, the terms of employment are expressed or implied but does not include any person-

a) Who is employed mainly in a managerial or administrative capacity; or

b) Who being employed in a supervisory capacity draws wages exceeding Rupees Two thousand Five hundred per person or exercises either by the nature of the duties attached to the office or by reason of powers vested to him, functions mainly of managerial nature.

c) Who is an out worker, that is to say, a person to whom any articles or materials are given out by or on behalf of the principal Employer to be made up cleaned, washed, altered, ornamental finished, repaired, adopted or otherwise processed for sale for the purpose of the trade or business of the principal Employer and the process is to be carried out either in the home of the out worker or in some other premises, not being premises under the control and management of the principal Employer.

2.2 “Fair Wages” means wages whether for time or piecework fixed and notified under the provisions of the minimum Wages Act from time to time.

2.3 “Contractor” shall include every person who undertake to produce a given result other than a mere supply of goods or articles of manufacture through labour or who supplies labour for any work and includes a sub-Contractor.

2.4 “Wages” shall have the same meaning as defined in the Payment of Wages Act.

2.4.1 Normally working hours of an adult employee should not exceed 9 hours a day. The working day shall be so arranged that inclusive of interval for rest, if any, it shall not spread over more than 12 hours on any day.

2.4.2 When an adult worker is made to work for more than 9 hours on any day or for more than 48 hours in any week he shall be paid overtime for the extra hours put in by him at double the ordinary rate of wages.
2.4.3.1 Every worker shall be given a weekly holiday on a Sunday, in accordance with the provisions of the Minimum Wages (Central) Rules 1960 as amended from time to time, irrespective of whether such worker is governed by the Minimum Wages Act or not.

2.4.3.2 Whether the Minimum Wages prescribed by the Government under the Minimum Wages Act are not inclusive of the wages for the weekly day of rest, the worker shall be entitled to rest day wages at the rate applicable to the next preceding day, provided he has worked under the same Contractor for a continuous period of not less than 6 days.

2.4.3.3 Here a Contractor is permitted by the Engineer-In-Charge to allow a worker to work on a normal weekly holiday, he shall grant a substitute holiday to him for the whole day on one of the five days immediately before or after the normal weekly holidays and pay wages to such worker for the work performed on the normal weekly holiday at overtime rate.

3.0 DISPLAY OF NOTICE REGARDING-WAGES, ETC.

The Contractor shall before he commences his work on contract, display and correctly maintain and continue to display and correctly maintain in a clean and legible condition in conspicuous places on the work, notices in English and in the local Indian languages spoken by the majority of the workers, giving the minimum rates of wages fixed under the Minimum Wages Act, the actual wages being paid, the hours of work for which such wages are earned, wage period, dates of payment of wages and other relevant information as per Appendix ‘A’.

4.0 PAYMENT OF WAGES

4.1 The Contractor shall fix wage periods in respect of which wages shall be payable.

4.2 No wage period shall exceed one month.

4.3 The wages of every person employed as labour in an establishment or by a Contractor where less than one thousand, such persons are employed shall be paid before the expiry of the seventh day and in other cases before the expiry of tenth day after the last day of the wage period in respect of which the wages are payable.

4.4 Where the employment of any worker is terminated by or on behalf of the Contractor the wages earned by him shall be paid before the expiry of the second working day from the date on which his employment is terminated.

4.5 All payments of wages shall be made on a working day at the work premises and during the working time and on a date notified in advance and in case the work is completed before the expiry of the wage period, final payment shall be made within 48 hours of the last working day.
4.6  Wages due to every worker shall be paid to him direct or to other person authorized by him in this behalf.

4.7  All wages shall be paid in current coin or currency or in both.

4.8  Wages shall be paid without any deductions of any kind except those specified by the Central Government by general or special order in this behalf or permissible under the Payment of Wages Act 1956.

4.9  A notice showing the wage period and the place and time of disbursement of wages shall be displayed at the place of work and a copy sent by the Contractor to the Engineer-In-Charge under acknowledgment.

4.10  It shall be the duty of the Contractor to ensure the disbursement of wages in the presence of the Engineer or any other authorized representatives of the Engineer-In-Charge who will be required to be present at the place and time of disbursement of wages by the Contractor to workmen.

4.11  The Contractor shall obtain from the Engineer or any other authorized representative of the Engineer-In-Charge as the case may be, a certificate under his signature at the end of the entries in the “Register of Wages” or the “Wage-cum-Muster Roll” as the case may be in the following form:

“Certified that the amount shown in column No............ has been paid to the workmen concerned in my presence on............. at .............”

5.0  FINES AND DEDUCTIONS, WHICH MAY BE MADE FROM WAGES

5.1  The wages of a worker shall be paid to him without any deduction of any kind except the following:

a)  Fines

b)  Deductions for absence from duty i.e. from the place or the places where by the terms of his employment he is required to work. The amount of deduction shall be in proportion to the period for which he was absent.

c)  Deduction for damage to or loss of goods expressly entrusted to the employed persons for custody, or from loss of money or any other deduction which he is required to account where such damage or loss is directly attributable to his neglect or default.

d)  Deduction for recovery of advances or for adjustment of over payment of wages, advances granted shall be entered in a register.

e)  Any other deduction, which the Central Government may from time to time allow.

5.2  No fines should be imposed on any worker save in respect of such acts and omissions on his part as have been approved by the Chief Labour Commissioner.
NOTE: An approved list of Acts and Omissions for which fines can be imposed is enclosed at Appendix-I.

5.3 No fine shall be imposed on a worker and no deduction for damage or loss shall be made from his wages until the worker has been given an opportunity of showing cause against such fines or deductions.

5.4 The total amount of fine which may be imposed in any one-wage period on a worker shall not exceed an amount equal to three paise in a Rupee of the total wages, payable to him in respect of that wage period.

5.5 No fine imposed on any worker shall be recovered from him in installment, or after the expiry of sixty days from the date on which it was imposed.

5.6 Every fine shall be deemed to have been imposed on the day of the act or omission in respect of which it was imposed.

6.0 LABOUR RECORDS

6.1 The Contractor shall maintain a “Register of persons employed” on work on contract in form XIII of the CL (R&A) Central Rules 1971 (Appendix-B).

6.2 The Contractor shall maintain a “Muster Roll” register in respect of all workmen employed by him on the work under contract in from XVI of the CL (R&A) Rules 1971 (Appendix-C).

6.3 The Contractor shall maintain a “Wage Register” in respect of all workmen employed by him on the work in form (Appendix-D).

6.4 Register of accidents – The Contractor shall maintain a register of accidents in such form as may be convenient at the work place but the same shall include the following particulars:

a) Full particulars of the labourers who met with accident.
b) Rate of wages
c) Sex
d) Age
e) Nature of accident and cause of accident.
f) Time and date of accident.
g) Date and time when he/she admitted in Hospital
h) Date of discharge from the Hospital
i) Period of treatment and result of treatment
j) Percentage of loss of earning capacity and disability as assessed by Medical Officer.
k) Claim required to be paid under Workmen’s Compensation Act.
l) Date of payment of compensation.
m) Amount paid with details of the person to whom the same was paid.
n) Authority by whom the compensation was assessed.
o) Remarks.
6.5  Register of Fines – The Contractor shall maintain a “Register of Fines” in the form (Appendix-H).

The Contractor shall display in a good condition and in a conspicuous place of work the approved list of Acts and Omission for which fines can be imposed (Appendix-I).

6.6  Register of Deductions-The Contractor shall maintain a “Register of Deductions” for damage or loss in form (Appendix-J).

6.7  Register of Advances-The Contractor shall maintain a “Register of Advances” in form (Appendix-K).

6.8  Register of Overtime-The Contractor shall maintain a “Register of Overtime” in form (Appendix-L).

7.0  ATTENDANCE CARD-CUM WAGE SLIP:

7.1  The Contractor shall issue an attendance card-cum-wage slip to each workman employed by him in the specimen form at (Appendix-E).

7.2  The card shall be valid for each wage period.

7.3  The Contractor shall mark the attendance of each workman on the card twice each day, once at the commencement of the day and again after the rest interval, before he actually starts work.

7.4  The card shall remain in possession of the worker during the wage period under reference.

7.5  The Contractor shall complete the wage slip portion on the reverse of the card at least a day prior to the disbursement of wages in respect of the wage period under reference.

7.6  The Contractor shall obtain the signature or thump impression of the worker on the wage slip at the time of disbursement of wages and retain the card with himself.

8.0  EMPLOYMENT CARD

The Contractor shall issue an Employment Card in form to each worker within three days of the employment of the worker (Appendix-F).

9.0  SERVICE CERTIFICATE

On termination of employment for any reason whatsoever the Contractor shall issue to the workman whose services have been terminated, a service certificate in from Appendix-G.
10.0 PRESERVATION OF LABOUR RECORDS

All records required to be maintained under Regulations Nos. 6 and 7 shall be preserved in original for a period of three years from the date of last entries made in them and shall be made available for inspection by the Engineer-In-Charge, Labour Officer.

11.0 POWER OF LABOUR OFFICERS TO MAKE INVESTIGATIONS INQUIRY

The Labour Officer or any other person authorized by EPI on its behalf shall have power to make inquiries with a view to ascertaining and enforcing due and proper observance of the Fair Wage Clauses and the Provisions of Regulations. He shall investigate into any complaint regarding the default made by the Contractor or sub-Contractor in regard to such provision.

12.0 INSPECTION OF BOOK AND SLIPS

The Contractor shall allow inspection of all the prescribed labour records to any of his workers or to his agent at a convenient time and place after due notice is received or to the Labour officer or any other person, authorized by the Central Government on his behalf.

13.0 SUBMISSION OF RETURNS

The Contractor shall submit periodical returns as may be specified from time to time.

14.0 AMENDMENTS

EPI may from to time, add or amend the regulations and on any question as to the application, interpretation or effect of these regulations the decision of the Zonal Chief concerned shall be final.
Appendix – ‘A’

LABOUR BOARD

Name of work
Name of Contractor
Address of Contractor
Name and Address of Unit
Name of Labour Enforcement Officer
Address of Labour Enforcement Officer
Date:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Category</th>
<th>Minimum wage fixed</th>
<th>Actual wages paid</th>
<th>Number present</th>
<th>Remarks</th>
</tr>
</thead>
</table>

Weekly Holiday
Wage Period
Date of Payment of wages
Working hours
Rest interval
FORM 13

REGISTER OF WORKMEN EMPLOYED BY CONTRACTOR

Name and Address of Contractor

Name and Address of Establishment in/ under which contract is carried on

Nature and location of work

Name & Address of Principal Employer

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name and surname of workman</th>
<th>Age &amp; sex</th>
<th>Father’s Husbands Name</th>
<th>Nature of employment / designation</th>
<th>Permanent home address of the workman (village and Tehsil Taluk and District)</th>
<th>Local address</th>
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<thead>
<tr>
<th>Date of commencement of employment</th>
<th>Signature or thumb impression of the workman</th>
<th>Date of termination of employment</th>
<th>Reasons for termination</th>
<th>Remarks</th>
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</table>
**FORM XVI**

*(See Rule 78(2) (193)*

**MUSTER ROLL**

Name and address of Contractor

Name and address of establishment in/under which contract is carried on

Nature and location of work

Name and Address of Principal Employer

For the month / fortnight

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the workman</th>
<th>Sex</th>
<th>Father's / Husband's Name</th>
<th>Dates</th>
<th>Remarks</th>
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### FORM XVII

[SEE RULE 78(2) (03)]

**REGISTER OF WAGES**

Name and address of Contractor

Name and address of establishment in/under which contract is carried on

Nature and location of work

Name and Address of Principal Employer

Wage period: per month/ fortnightly

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Workman</th>
<th>Serial No. in the register of workman</th>
<th>Designation nature of work done</th>
<th>Nos. of days worked</th>
<th>Units of work done</th>
<th>Daily rate of wages/ piece rate</th>
<th>Basic Wages</th>
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</table>

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<thead>
<tr>
<th>Dearness allowance</th>
<th>Overtime</th>
<th>Other cash payments</th>
<th>Total</th>
<th>Duration if any (indicate)</th>
<th>Net Amt</th>
<th>Signature thumb impression of the workman</th>
<th>Initial Contractor or his representative</th>
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</table>
FORM XIX

[SEE RULE 78 (2) (B)]

WAGES SLIP

Name and address of Contractor

Name and Father’s/Husband's Name of workman

Nature and location of work

For the Week/Fortnight/Month ending

1. No. of days worked

2. No. of Units worked in case of piece rate workers

3. Rate of daily wages/piece rate

4. Amount of overtime wages

5. Gross wages payable

6. Deductions if any

7. Net amount of wages paid

Sign of the Contractor
WAGE CARD

WAGE CARD NO.

NAME AND ADDRESS OF CONTRACTOR          DATE OF ISSUE

NATURE OF WORK WITH LOCATION              DESIGNATION

NAME OF WORKMAN                           MONTH/FORTNIGHT

RATE OF WAGES

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22| 23| 24| 25|
| 26| 27| 28| 29| 30| 31|

MORNING          RATE

EVENING          AMOUNT

INITIAL

RECEIVED FROM   THE SUM OF RS.   ON ACCOUNT

OF MY WAGON.

SIGNATURE

THE WAGE CARD IS VALID FOR ONE MONTH FROM THE DATE OF ISSUE.
FORM XIV
(SEE RULE 76)

EMPLOYMENT CARD

Name and address of Contractor

Name and address of establishment under which
The contract is carried out

Nature and location of work

Name and address of Principal Employer

1. Name of the workman
2. S. Name in the register of workman employed
3. Nature of Employment/Designation
4. Wage rate (with particulars of unit in case of piece work)
5. Wage Period
6. Tenure of employment
7. Remarks

Signature of Contractor
### FORM XV

(SEE RULE 77)

**SERVICE CERTIFICATE**

- Name and address of Contractor
- Nature and location of work
- Name and address of workman
- Age or date of birth
- Identification Marks
- Father's/Husband's Name
- Name and address of establishment in which contract is carried on
- Name and address of Principal Employer
- Total period of which employed

<table>
<thead>
<tr>
<th>S.No.</th>
<th>From</th>
<th>To</th>
<th>Nature of work</th>
<th>Rate of wages (with particulars of unit in case of piece work)</th>
<th>Remarks</th>
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**Signature**
FORM XII

[SEE RULE 78 (2) (D)]

REGISTER OF FINES

Name and address of Contractor

Name and address of establishment in/ under which contract is carried on

Nature and location of work

Name and address of workman

Name and address of Principal Employer

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of workman</th>
<th>Father’s/Husband Name</th>
<th>Designation/nature of employment</th>
<th>Act/Omission for which fine imposed</th>
<th>Date of offence</th>
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Whether workman showed causes against fine

Name of person in whose presence employees explanation was heard

Wage period and wages payable

Amount of fine Imposed

Date on which fine realized

Remarks

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</table>
Appendix – ‘I’

LIST OF ACTS AND OMISSIONS FOR WHICH FINES CAN BE IMPOSED

In accordance with rule of Labour Regulations, to be displayed prominently at the Site of work both in English and local language.

1. Willful insubordination or disobedience, whether alone or in combination with other.
2. Theft, fraud or dishonestly in connection with Contractors beside a business or property of EPI.
3. Taking or giving bribes or any illegal gratifications.
4. Habitual late attendance.
5. Drunk-ness fighting riotous or disorderly or indifferent behaviour.
6. Habitual negligence.
7. Smoking near or around the area where combustible or other materials are locked.
8. Habitual indiscipline.
9. Causing damage to work in the progress or to property of EPI or of the Contractor.
10. Sleeping on duty.
11. Malingering or slowing down work.
12. Giving the false information regarding name, age, fathers name etc.
13. Habitual loss of wage cards supplied by the Employer.
14. Unauthorized use of Employers property or manufacturing or making of unauthorized articles at the work place.
15. Bad workmanship in construction and maintenance by skilled workers, which is not approved by EPI for which the Contractors are compelled to undertake rectifications.
16. Making false complaints and/or misleading statements.
17. Engaging on trade within the premises of the establishment.
18. Any unauthorized divulgence of business affairs of the employees.
19. Collection or canvassing for the collection of any money within the premises of an establishment unless authorized by the Employer.
20. Holding meeting inside the premises without previous sanction of the Employers.
21. Threatening or intimidating any workman or employee during the working hours within the premises.


**FORM XX**

[SEE RULE 78 (2) (D)]

**REGISTER OF DEDUCTION FOR DAMAGES OR LOSS**

Name and address of Contractor

Name and address of establishment in/ under which contract is carried on

Nature and location of work

Name and address of Principal Employer

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of workman</th>
<th>Father’s/Husband Name</th>
<th>Designation/nature of employment</th>
<th>Particulars of damage or loss</th>
<th>Date of damage/loss</th>
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### Date of recovery

<table>
<thead>
<tr>
<th>Whether workman showed cause against deductions</th>
<th>Name of person in whose presence employees explanation was heard</th>
<th>Amount of deduction Imposed</th>
<th>No. of installment</th>
<th>First Installment</th>
<th>Last Installment</th>
<th>Remarks</th>
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FORM XXII

[SEE RULE 78(2)]

REGISTER OF ADVANCES

Name and address of Contractor

Name and address of establishment in/ under which contract is carried on

Nature and location of work

Name and address of Principal Employer

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of workman</th>
<th>Father’s/Husband Name</th>
<th>Designation/nature of employment</th>
<th>Wages period and wages payable</th>
<th>Date and amount of advance given</th>
</tr>
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<thead>
<tr>
<th>Purpose / for which advance made</th>
<th>No. of installments by which advance is to be paid</th>
<th>Date and amount of each installment repaid</th>
<th>Date on which last installment was repaid</th>
<th>Remarks</th>
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FORM XXIII

[See Rule 78(2) (E)]

REGISTER OF OVERTIME

Name and address of Contractor

Name and address of establishment in/ under which contract is carried on

Nature and location of work

Name and address of Principal Employer

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of workman</th>
<th>Father’s/Husband Name</th>
<th>Sex</th>
<th>Designation/ nature of employment</th>
<th>Date on which overtime worked</th>
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Total overtime worked or production in case of piece rated

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<tr>
<th>Total overtime worked or production in case of piece rated</th>
<th>Normal rate of wages</th>
<th>Overtime rate of wages</th>
<th>Overtime earning</th>
<th>Rate on which overtime wages paid</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>
APLICATION FOR EXTENSION OF TIME

(To be completed by the Contractor)

PART –I

1. Name of Contractor
2. Name of the work as given in the Agreement
3. Agreement No.
4. Estimated amount put to Tender
5. Date of commencement work as per agreement
6. Period allowed for completion of work as per agreement
7. Date of completion stipulated as per agreement
8. Period for which extension of time has been given previously
   Extension granted
   a) First extension vide Engineer-in-charge letter No… ……date Months Days
   b) 2nd extension vide Engineer-in-charge letter No………. date Months Days
   c) 3rd extension vide Engineer-in-charge letter No………. date Months Days
   d) 4th extension vide engineer-in-charge letter No………. date Months Days

Total extension previously given

9. Reasons for which extension have been previously given (copies of the previous application should be attached)

10. Period for which extension is applied for:

11. Hindrances on account of which extension is applied for with dates on which hindrances occurred, and the period for which these are likely to last.
   a) Serial No.
   b) Nature of hindrance
c) Date of Occurrence

d) Period for which it is likely to last

e) Period for which extension required for this particular hindrance.

f) Overlapping period, if any, with reference to item

g) Net extension applied for

h) Remarks, if any

Total period for which extension is now applied for on account of hindrances mentioned above ............. Month/ days.

12. Extension of time required for extra work.

13. Details of extra work and on the amount involved:

   a) Total value of extra work
   b) Proportionate period of extension of time based on estimated amount put to tender on account of extra work.

14. Total extension of time required for 11 & 12
Submitted to the Engineer-In-Charges office.

SIGNATURE OF CONTRACTOR

DATE
APPLICATION FOR EXTENSION OF TIME

(PART – II)

1. Date of receipt of application from Contractor for the work in the Engineer-In-Charge office.

2. Acknowledgement issued by Engineer-In-Charge vide his letter No dated

3. Engineer-In-Charge remarks regarding hindrances mentioned by the Contractor.
   i) Serial No.
   ii) Nature of hindrance
   iii) Date of occurrence of hindrance
   iv) Period for which hindrance, is likely to last
   v) Extension of time period applied for by the Contractor
   vi) Overlapping period, if any, giving reference to items which overlap
   vii) Net period for which extension is recommended.
   viii) Remarks as to why the hindrance occurred and justification for extension recommended.

4. Engineer-In-Charge recommendations.

   (The present progress of the work should be stated and whether the work is likely to be completed by the date upto which extension has been applied for. If extension of time is not recommended, what compensation is proposed to be levied under the agreement.

SIGNATURE OF ENGINEER-IN-CHARGE

APPROVAL OF ZONAL HEAD
PROFORMA FOR EXTENSION OF TIME

PART – III

To

NAME

ADDRESS OF THE CONTRACTOR

SUBJECT:

Dear Sir(s)

Reference your letter No __________ dated __________, in connection with the grant of extension of time for completion of the work…..

The date of completion for the above mentioned work, is ____________ ____________ as stipulated in the agreement, dated ____________

Extension of time for completion of the above mentioned work is granted upto ____________, without prejudice to the right of EPI to recover compensation for delay in accordance with the provision made in the relevant Clause (s) of the said agreement dated the ___/ ___/ ___. It is also clearly understood that EPI shall not consider any revision in contract price or any other compensation whatsoever due to grant of this extension.

Provided that notwithstanding the extension hereby granted, time is and shall still continue to be the essence of the said agreement.

Yours faithfully,

FOR EPI LTD.
PROFORMA FOR BANK GURANTEE IN LIEU OF EARNEST MONEY DEPOSIT

In consideration of Chairman & managing Director, Engineering Projects (India) Limited, (A Govt. of India Enterprise), Core-3, Scope Complex, Lodhi Road, New Delhi Pin-110003. (hereinafter called the EPI) having agreed to accept bank Guarantee of Rs ........................ in lieu of EARNEST MONEY DEPOSIT from ................................................................. (hereinafter called the Supplier/ Contractor/ Sub-Contractor, which expression shall include its heirs, successors and assignees) in respect of the Tender for ..................................................................................................................

We, ........................................ bank having its registered/head office at ................................... (hereinafter referred to as the Bank) do hereby agree and undertake to pay to EPI without demur or protest an amount not exceeding Rs.......................... on demand by EPI.

We the above said Bank further agree and undertake to pay the said amount of Rs........................ without any demur on demand within 48 hours. Any demand made on the Bank by EPI shall be conclusive as regards the amount due and payable by the Bank under this guarantee.

We the above said Bank further agree that the guarantee herein contained shall be in full force and in effect until ............................................................... date ..............................

Unless a demand or claim under this guarantee is made on us in writing on or before ............................................................... date .............................. , we shall be discharged from all liabilities under this guarantee thereafter.

We, the above said Bank, further agree that EPI shall have full liberty, without our consent and without affecting in any manner our obligation to verify, modify or delete any of the conditions.

We, the above said Bank, lastly undertake not to revoke this guarantee during its currency except with the prior consent of EPI in writing.

Dated…………………………this day of……………..200.

For and on behalf of the Bank

NOTE: on a Non-Judicial stamp paper of Rs. 100/- (Rupees One hundred only)
The Chairman & Managing Director  
(A Govt. of India Enterprise),  
Engineering Projects (India) Ltd.  
Core-3, SCOPE Complex  
7, Institutional Area, Lodhi road  
New Delhi – 110 003

Dear Sir,

In consideration of the Chairman & Managing Director, Engineering Projects (India) Ltd.  
(A Govt. of India Enterprise), Core-3, Scope Complex, 7 Institutional Area, Lodhi Road,  
New Delhi – 110 003 (hereinafter called ‘EPI’ which expression shall unless repugnant to  
the subject or context includes its successors and assigns) having agreed under the  
terms and conditions of Supply Contract/Contract/Sub-Contract  
no._________________________________________ Dated_______________________  
made between M/s_________________________________________ (hereinafter referred to as  
the said Supplier/Contractor/Sub-Contractor) which expression shall unless repugnant to the  
subject or context includes its successors and assigns) and EPI in connection with  
______________________________________________ (hereinafter called ‘The said  
Supply Contract/Contract/Sub-Contract) to accept a Deed Security Deposit-cum-  
Performance Bank Guarantee as herein provided for ________________________in  
lieu of :

a) The Security Deposit to be made by the said Supplier/Contractor/Sub-Contractor  
for the due fulfillment by the said Supplier/Contractor/Sub-Contractor of the terms  
and conditions contained in the said Supply Contract/Contract/Sub-contract, and

b) Fulfillment of the conditions of the said Supply Contract /Contract/Sub-Contract  
by furnishing a security for the performance of the works and/or  
equipment/materials supplied in accordance with conditions of the said Supply  
Contract/ Contract/ Sub-Contract.

1. We _____________________________ (hereinafter referred to as “the said bank  
which expression shall unless repugnant to the subject or context includes its  
successors and assigns) and having our registered office at  
_________________________ do hereby unconditionally and irrevocably undertake  
and agree to indemnify and keep indemnified EPI from time to time to the extent of  
_______________________________ Only against any loss, damages, costs,  
charges and expenses caused to or suffered by or that may be caused or suffered by  
EPI by reason of any breach or breaches by the said Supplier/Contractor/Sub-  
Contractor of any of the terms and conditions contained in the said Supply  
Contract/Contract/Sub-Contract and or any amount becoming due for non-
performance and/or penalty as assessed by EPI and top unconditionally pay the amount claimed by EPI on demand and without demur and protest.

2. We the said Bank further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Supply Contract/Contract/Sub-Contract and till all the dues of EPI under the said Supply Contract/Contract/Sub-Contract or by virtue of any of the terms and conditions governing the said Supply Contract/Contract/Sub-Contract have been fully paid and its claims satisfied or discharged and till EPI certifies that the terms and conditions of the said Supply Contract/Contract/Sub-Contract have been fully and properly carried out by the said Supplier/Contractor/Sub-Contractor and accordingly discharge this guarantee subject, however, that EPI shall have no claim under this guarantee after 6 months from the date of expiry of the guarantee unless a notice of the claim under this guarantee has been served on the Bank before the expiry of the said period of 6 months.

3. EPI shall have the fullest liberty without affecting in any way the liability of the said Bank under this Guarantee or indemnity from time to time to vary any of the terms and conditions of the said Supply Contract/Contract/Sub-Contract to extend time of performance of the said Supply Contract/Contract/Sub-Contract or to postpone for any time and from time to time any power’s exercisable by it against the said Supplier/Contractor/Sub-Contractor and either to enforce or forbear from enforcing any of the terms and conditions governing the said Supply Contract/Contract/Sub-Contract or securities available to EPI and the said Bank shall not be released from its liability under these presents by any exercise by EPI of the liberty with reference to the matters aforesaid or by reason of time being given to the said Supplier/Contractor/Sub-Contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of so releasing the said Bank from its such liability.

4. We, the said Bank, further agree that EPI shall be the sole judge of and as to whether the said Supplier/Contractor/Sub-Contractor has committed any breach or breaches of any of the terms and conditions of the said Supply Contract/Contract/Sub-Contract and the extent of loss, damage, cost, charges and expenses caused to or suffered by or that may be caused to or suffered by EPI on account thereof and the decision of EPI that the said Supplier/Contractor/Sub-Contractor has committed such breach or breaches and as to the amount or amounts of loss, damages, costs, charges and expenses caused to or suffered by EPI from time to time shall be final and binding on the Bank.

5. This guarantee shall be a continuing guarantee and shall remain valid and irrevocable for all claims of EPI and liabilities of the said Supplier/Contractor/Sub-Contractor arising up to and until mid night of ________________________, subject the claim period as mentioned in para ______________.

6. This guarantee shall be in addition to any other guarantee or security whatsoever that EPI may now or at any time anywise may have in relation to the said Supplier/Contractor/Sub-Contractor obligation/liabilities under and/or in connection with the said Supply Contract/Contract/Sub-Contract and EPI shall have full authority to take recourse to or enforce this guarantee in preference to any other guarantee or
security which EPI may have or obtain and there shall be no forbearance on the part of EPI IN ENFORCING OR REQUIRING ENFORCEMENT OF ANY OTHER SECURITY AND shall not have the effect of releasing the said Bank from its full liability hereunder.

7. EPI shall be at liberty without reference to the said Bank and without effecting the full liability of the said Bank hereunder to take any other security in respect of the said supplier's/Contractor's/sub-Contractor's obligations and/or liabilities under or in connection with the said Supply Contract/Contract/Sub-Contract.

8. This guarantee shall not be determined or affected by the liquidation or winding up, dissolution, or change of constitution or insolvency of the said Supplier/Contractor/Sub-Contractor, but shall in all respects and for all purposes be binding and operative until payment of all moneys paid to EPI in terms thereof.

9. The said Bank hereby waives all rights at any time inconsistent with the terms of this guarantee and the obligations of the said Bank in terms hereof shall not be anywise affected or suspended by reasons of any dispute or disputes having been raised by the said Supplier/Contractor/Sub-Contractor (whether or not pending before any arbitrator, tribunal or court) of any denial or liability by the said Supplier/Contractor/Sub-Contractor stopping or preventing or purporting to stop or prevent any payment by the said Bank to EPI in terms hereof. The amount stated in any notice of demand addressed by EPI to the Guarantor Bank as liable to be paid to EPI by the Supplier/Contractor/Sub-Contractor on account of any losses or damages or costs, charges and/or expenses shall as between the said bank and EPI be conclusive evidence of the amount so liable to be paid to EPI or suffered or incurred by EPI as the case may be and payable by the said Bank to EPI in terms hereof. We, the said Bank further undertake that we shall pay forthwith the amount stated in the notice of demand to EPI without demur and protest.

10. We, the said bank undertake not to revoke this guarantee during its currency except with the consent of EPI in writing and agree that any change in the constitution of the said Supplier/Contractor/Sub-Contractor or the said Bank shall not discharge our liabilities hereunder.

11. It shall not be necessary for EPI to proceed against the said Supplier/Contractor/Sub-Contractor before proceeding against the Bank and the guarantee herein contained shall be enforceable against the Bank notwithstanding any security which EPI may have obtained or obtain from the said Supplier/Contractor/Sub-Contractor shall at the time when proceedings are taken against the said Bank hereunder be outstanding or unrealized.

12. Our liability under this guarantee shall be restricted to _______________ and this guarantee shall remain in force until midnight of _______________ unless a claim to enforce this guarantee is filed with us within six months from _______________. (which is date of expiry of this guarantee), we shall be discharged from all liabilities under this guarantee thereafter.

DATED ---------------------------- THIS day of -----------------------200...

FOR AND ON BEHALF OF BANK
PROFORMA FOR ADVANCE BANK GUARANTEE

To

The Chairman & Managing Director,
Engineering Projects (India) Ltd.,
(A Govt. of India Enterprise),
Core-3, Scope Complex,
7, Institutional Area,
Lodhi Road,
New Delhi—110 003.

Dear Sir,

1. In consideration of the Chairman & Managing Director, Engineering Projects (India) Limited, (A Govt. of India Enterprise), Core-3, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi – 110 003 (hereinafter called 'EPI' which expression shall includes its successors and assigns) having agreed under the terms and conditions of Supply Contract/ Contract/ Sub-Contract No………………………dated...(hereinafter referred to as the said Supply Contract/ Contract/ Sub-Contract) made between EPI and……………………...hereinafter called the Supplier/ Contractor/ Sub-Contractor) which expression shall include its successors and assigns to make at the request of the Supplier/ Contractor/ Sub-Contractor a lump sum advance of Rs…………..for utilising it only for the purposes of the said Supply Contract/ Contract/ Sub-Contract on his furnishing a guarantee acceptable to EPI.

2. We, the... ............................Bank (hereinafter referred to as 'the said Bank) a Company under the Companies Act 1956 and having our registered office at……………………...do hereby guarantee the recovery of the said advance and interest thereon as provided according to the terms and conditions of the said Supply Contract/ Contract/ Sub-Contract. If the Supplier/ Contractor/ Sub-Contractor fails to utilise the said advance for the purposes of the said Supply Contract/ Contract/ Sub-Contract and/or the said advance together with interest thereon as aforesaid is not fully recovered by EPI, we. .............Bank hereby unconditionally and irrevocably undertake to pay the EPI on demand and without demur or protest to the extent of the said sum of Rs…………..any claim made by EPI on us against non-utilisation / misutilisation of the said advance and/or by reason of EPI not being able to recover in full the sum of Rs………….. with interest as aforesaid.

3. We............................Bank further agree that EPI shall be the sole judge of and as to whether the said Supplier/ Contractor/ Sub-Contractor has utilised or not utilised the said advance or any part thereof for the purposes of the said Supply Contract/ Contract/ Sub-Contract and/or as to whether the advance or any part thereof with
interest has been recovered or not and the finding of the EPI in this regard shall be final and binding on us.

4. We, the said Bank further agree that the Guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Supply Contract/ Contract/ Sub-Contract and till the said advance with interest has been fully recovered and its claims satisfied or discharged and till EPI certifies that the said advance with interest has been fully recovered from the Supplier/ Contractor/ Sub-Contractor.

5. EPI shall have the fullest liberty without affecting in any way the liability to the said Bank under this guarantee or indemnity from time to time to vary any of the terms and conditions of the said Supply Contract/ Contract/ Sub-Contract, or the advance or to extend time of performance by the said Supplier/ Contractor/ Sub-Contractor or to postpone for any time and from time to time any powers exercisable by it against the said Supplier/ Contractor/ Sub-Contractor and either to enforce or forbear from enforcing any of the terms and conditions governing the said Supply Contract/ Contract/ Sub-Contract or securities available to EPI and the said Bank shall not be released from its liability under these presents by any exercise by EPI of the liberty with reference to the matters aforesaid or by reason of time being given to the said Supplier/ Contractor/ Sub-Contractor or any other forbearance, act or omission on the part of the EPI or any indulgence by EPI to the said Supplier/ Contractor/ Sub-Contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of so releasing the said Bank from its such liability.

6. The Bank hereby waives all rights at any time inconsistent with the terms of this guarantee/Undertaking and the obligations of the Bank in terms hereof shall not be anywise affected or suspended by reasons of any dispute or disputes having been raised by the Supplier/ Contractor/ Sub-Contractor (whether or not pending before any arbitrator, Tribunal or court) or any denial or liability by the Supplier/ Contractor/ Sub-Contractor stopping or preventing or purporting to stop or prevent any payment by the Bank to EPI in terms hereof.

7. The amount stated in any notice of demand addressed by EPI to Bank as liable to be paid to EPI by the Supplier/ Contractor/ Sub-Contractor, shall be conclusive evidence of the amount so liable to be paid to EPI by the Bank.

8. This guarantee/undertaking shall be in addition to any other guarantee or security whatsoever that EPI may now or any time anywise may have in relation to the Supplier’s/ Contractor’s/ Sub-Contractor’s obligations of liabilities under and/or in connection with the said Supply Contract/ Contract/ Sub-Contract, and EPI shall have full authority to take recourse to or enforce this security in preference to any other guarantee or security which EPI may have or obtain and there shall be no forbearance on the part of EPI in enforcing or requiring enforcement of any other security and shall not have the effect of releasing the Bank from its full liability hereunder.

9. It shall not be necessary for EPI to proceed against the said Supplier/ Contractor/ Sub-Contractor before proceeding against the Bank and the guarantee herein contained shall be enforceable against the Bank notwithstanding any security which EPI may have obtained or obtain from the Supplier/ Contractor/ Sub-Contractor, shall at the time
when proceedings are taken against the said Bank hereunder be outstanding or unrealised.

10. We, ..................................... the said Bank further undertake that we shall pay forthwith the amount stated in the notice of demand without demur and protest notwithstanding any dispute/difference pending between the parties before the arbitrator Tribunal or Court and/or dispute is being referred to arbitrator.

11. We, the said Bank undertake not to revoke this Guarantee during its currency except with the consent of EPI in writing and agree that any change in the Constitution of the said Supplier/ Contractor/ Sub-Contractor or the said Bank shall not discharge our liability hereunder.

12. This guarantee/undertaking shall be a continuing guarantee/undertaking and shall remain valid and irrevocable for all claims of EPI and liabilities of the Supplier/ Contractor/ Sub-Contractor arising up to and until midnight of……….

13. Notwithstanding anything contained herein above, our liability under this guarantee shall be restricted to Rs………………. (Rs ………………………………….) and this guarantee shall remain in full force till……………. unless a claim is made on us within 3 months from the date of expiry of this guarantee i.e. before all the claims under this guarantee shall be forfeited and we shall be relieved of and discharged from our liabilities hereunder.

Dated…………………………………………….day of……………………………………200

For and on behalf of Bank
PROFORMA FOR PERFORMANCE BANK GUARANTEE

To

The Chairman & Managing Director,
Engineering Projects (India) Ltd.,
(A Govt. of India Enterprise),
Core-3, Scope Complex,
7, Institutional Area,
Lodhi Road,
New Delhi—110 003.

Dear Sir,

In consideration of the Chairman & Managing Director, Engineering Projects (India) Limited, (A Govt. of India Enterprise), Core-3, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi – 110 003 (hereinafter called ‘EPI’ which expression shall include its successors and assigns) having awarded to ……………… (hereinafter referred to as ‘the Supplier/ Contractor/ Sub-Contractor’ which expression shall wherever the subject or context so permits include its successors and assigns) a Supply Contract/Contract / Sub-Contract No. ……………… in terms inter alia, of EPI Letter No. ………………dated… and the General Conditions of Contract/ General Purchase Conditions of EPI and upon the condition of the Supplier’s/ Contractor’s/ Sub-Contractor’s furnishing security for the performance of the Supplier’s/ Contractor’s/ Sub-Contractor’s obligations and/or discharge of the Supplier’s/ Contractor’s/ Sub-Contractor’s liability under and/or in connection with the said Supply Contract/ Contract/ Sub-Contract up to a sum of Rs……………(Rupees……………………….only).

1. We………………………………………………………………………………………….(hereinafter called ‘the Bank’ which expression shall include its successors and assigns) hereby jointly and severally undertake the guarantee to payment to EPI in rupees forthwith on demand in writing and without protest or demur or any and all monies anywise payable by the Supplier/ Contractor/ Sub-Contractor to EPI under in respect of or in connection with the said Supply Contract/ Contract/ Sub-Contract inclusive of all EPI’s losses and damages and costs, charges and expenses and other moneys anywise payable in respect to the above as specified in any notice of demand made by the EPI to the Bank with reference to this guarantee up to and aggregate limit of Rs……………(Rupees…………………………………………………..only).
2. We……………….. Bank further agree that EPI shall be sole judge of and as to whether the said Supplier/ Contractor/ Sub-Contractor has committed any breach or breaches of any of the terms and conditions of the said Supply Contract/ Contract/ Sub-Contract and the extent of loss, damage, cost, charges and expenses caused to or suffered by or that may be caused to or suffered by EPI on account thereof and the decision of EPI that the said Supplier/ Contractor/ Sub-Contractor has committed such breach or breaches and as to the amount or amounts of loss, damage, costs, charges and expenses caused to or suffered by EPI from time to time shall be final and binding on us.

3. EPI shall be at liberty without reference to the Bank and without effecting the full liability of the Bank hereunder to take any other security in respect of the Supplier’s/ Contractor’s/ Sub-Contractor’s obligations and/or liabilities under or in connection with the said Supply Contract/ Contract/ Sub-Contract and to vary the forms vis-à-vis the Supplier/ Contractor/ Sub-Contractor of the said Supply Contract/ Contract/ Sub-Contract or to grant time and/or indulgence to the Supplier/ Contractor/ Sub-Contractor or to reduce or to increase or otherwise vary the prices of the total Supply Contract/ Contract/ Sub-Contract Value or to release or to forbear from enforcement of all or any of the security and/or any other security(ies) now or hereafter held by the EPI and no such dealing(s) reduction(s) increase(s) or other indulgence(s) or arrangements with the Supplier/ Contractor/ Sub-Contractor or release or forbearance whatsoever shall absolve the bank of the full liability to EPI hereunder or prejudice rights of EPI against the bank.

4. The guarantee/undertaking shall not be determined or affected by the liquidation or winding up, dissolution, or change of constitution or insolvency of the Supplier/ Contractor/ Sub-Contractor but shall in all respects and for all purposes be binding and operative until payment of all moneys made to EPI in terms thereof.

5. The Bank hereby waives all rights at any time inconsistent with the terms of this guarantee/undertaking and the obligations of the Bank in terms hereof shall not be anywise affected or suspended by reasons of any dispute or disputes having been raised by the Supplier/ Contractor/ Sub-Contractor (whether or not pending before any arbitrator, Tribunal or Court) of any denial or liability by the Supplier/ Contractor/ Sub-Contractor stopping or preventing or purporting to stop or prevent any payment by the Bank to the EPI in terms hereof.

6. The amount stated in any notice of demand addressed by EPI to Bank as liable to be paid to EPI by the Supplier/ Contractor/ Sub-Contractor or as suffered or incurred by the EPI on account of any losses or damages or costs, charges and/or expenses shall be conclusive evidence of the amount so liable to be paid to EPI or suffered or incurred by EPI as the case may be and shall be payable by the Bank to EPI in terms hereof.
7. This guarantee/undertaking shall be a continuing guarantee/undertaking and shall remain valid and irrevocable for all claims of EPI and liabilities of the Supplier/ Contractor/ Sub-Contractor arising up to and until midnight of………….

8. This guarantee/undertaking shall be in addition to any other guarantee or security whatsoever that EPI may now or any time anywise may have in relation to the Supplier’s/ Contractor’s/ Sub-Contractor’s obligations of liabilities under and/or in connection with the said Supply Contract/ Contract/ Sub-Contract, and EPI shall have full authority to take recourse to or enforce this security in preference to any other guarantee of security which EPI may have or obtain and here shall be no forbearance on the part of EPI in enforcing or requiring enforcement of any other security and shall not have the effect of releasing the Bank from its full liability hereunder.

9. It shall not be necessary for EPI to proceed against the said Supplier/ Contractor/ Sub-Contractor before proceeding against the Bank and the guarantee herein contained shall be enforceable against the Bank notwithstanding any security which the EPI may have obtained or obtain from the Supplier/ Contractor/ Sub-Contractor, shall at the time when proceedings are taken against the said Bank hereunder be outstanding or unrealised.

10. We the said Bank undertake not to revoke this guarantee during its currency except with the consent of EPI in writing and agree that any change in the constitution of the said Supplier/ Contractor/ Sub-Contractor or the sand bank shall not discharge our liability hereunder.

11. We ………….the said Bank further undertake that we shall pay forthwith the amount stated in the notice of demand without demur and protest notwithstanding any dispute/difference pending between the parties before the arbitrator Tribunal or Court and/or any dispute is being referred to arbitrator.

12. Notwithstanding anything contained herein above, our liability under this guarantee shall be restricted to Rs………………………… (Rupees………………………………) and this guarantee shall remain in force till……………… unless a claim is made on us within 3 months from that date, that is before all the claims under this guarantee shall be forfeited and we shall be relieved of and discharged from our liabilities thereunder.

Dated……………………………………. day of…………………………………………….200

For and on behalf of Bank
PROFORMA FOR INDEMNITY BOND TO BE EXECUTED BY
THE CONTRACTOR FOR SECURED ADVANCE
AGAINST MATERIALS SUPPLIED FOR THE PROJECT

(On non-judicial stamp paper of appropriate value)

INDEMNITY BOND

THIS INDEMNITY BOND is made this __________________________ day of __________________ 20________ by __________________ (Contractor’s Name) a Company registered under the Companies Act, 1956/Partnership firm/Proprietary concern having its Registered Office at ______________ (hereinafter called as ‘Contractor’ which expression shall include its successors and permitted assigns) in favour of Engineering Projects (India) Limited, a Company incorporated under the Companies Act, 1956 having its Registered Office at Core-3, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi - 110 003 (hereinafter called “EPI” which expression shall include its successors and assigns) :

WHEREAS EPI has awarded to the Contractor a Contract for the work of ______________ vide its letter of Intent/Work Order No ____________ dated ______________ (hereinafter called the “Contract”) in terms of which EPI is required to give “Secured Advance” to the Contractor as per Clause no. 35 of the General Conditions of Contract against supply of materials by the Contractor for the project on the security of materials, the quantities, rates and other particulars of which are detailed in the Bill of Quantities for the said Contract.

And WHEREAS by virtue of Clause no. 35 of the General Conditions of Contract of the said Contract, the Contractor is required to execute an Indemnity Bond in favour of EPI for the amount of “Secured Advance” towards the materials actually supplied by the Contractor for the Contract Work from time to time to EPI for the purpose of performance of the Contract. (hereinafter called the “Materials”).

“AND WHEREAS the Contractor has applied to EPI that they may be allowed “Secured Advance” on the security of materials absolutely belonging to them and brought by them to the site of the works for use in construction of the work”.

NOW THEREFORE, This Indemnity Bond witnesseth as follows:

1. That in consideration of the “Secured Advance” being given to the Contractor as mentioned in the Contract, for the purpose of performance of the Contract, the Contractor hereby undertakes to indemnify and shall keep EPI indemnified, for the Actual Cumulative Amount of the “Secured Advance” given to the Contractor from time to time against the said Contract. The Contractor hereby acknowledges actual receipt of the materials etc. as per despatch title documents being /to be handed over to EPI from time to time. The Contractor shall hold such materials in trust as a “Trustee” for and on behalf of EPI.
2. That the Contractor is obliged and shall remain absolutely responsible for the safe transit/protection and custody of the materials at EPI’s project site against all risks whatsoever till the materials are duly used/erected in accordance with the terms of the Contract and the plant/package duly erected and commissioned in accordance with the terms of the Contract is taken over by EPI and the Secured Advance is fully adjusted/recovered as per terms of the Contract. The Contractor undertakes to keep EPI harmless against all losses, damages, deterioration and shortages that may be caused to the materials.

3. The Contractor undertakes that the materials shall be used exclusively for the performance/execution of the Contract strictly in accordance with its terms and conditions and no part of the materials shall be utilized for any other work or purpose whatsoever. It is clearly understood by the Contractor that non-observance of the obligations under this Indemnity Bond by the Contractor shall inter-alia constitute a criminal breach of trust on the part of the Contractor for all intents and purposes including legal/penal consequences.

4. That EPI is and shall remain the exclusive owner of the materials free from all encumbrances, charges or liens of any kind, whatsoever. The materials shall at all times be open to inspection and checking by the Engineer – In - Charge or other employees/agents authorized by him in this regard. Further, EPI shall always be free at all times to take possession of the materials in whatever form the materials may be, if in its opinion, the materials are likely to be endangered, misutilised or converted to uses other than those specified in the Contract, by any acts of omission or commission on the part of the Contractor or any other person or on account of any reason whatsoever and the Contractor binds himself and undertakes to comply with the directions of demand of EPI to handover the materials without any demur or reservation.

5. That this Indemnity Bond is irrevocable. If at any time any loss or damage occurs to the materials or the same or any part thereof is mis-utilised in any manner whatsoever, then the Contractor hereby agrees that the decision of the Engineer-In-Charge of EPI as to assessment of loss or damage to the materials shall be final and binding on the Contractor. The Contractor binds itself and undertakes to replace the lost and /or damaged materials at its own cost and/or shall pay the amount of ‘Secured Advance’ to EPI without any demur, reservation or protest. This is without prejudice to any other right or remedy that may be available to EPI against the Contractor to recover any amount or all the amounts of this Bond from any dues of the Contractor under the Contract or as per the law.

6. This Bond shall remain in force and effect till the completion of the work as per the aforesaid Contract and till all the amount recoverable under this Bond from the Contractor is fully recovered by EPI. The Bond can not be revoked by the Contractor without the written consent of EPI.

7. That Contractor also agrees that any change in the constitution of the Contractor shall not discharge them from their obligation and liability.

8. This Bond shall be treated as an additional addage to the Contract and nothing herein contained shall be construed to adversely affect the rights of EPI in the Contract.
IN WITNESS WHEREOF, the Contractor has signed this Indemnity Bond through its duly authorized representative on the date and place first above written.

For and on behalf of Contractor

(Contractor’s Name)

WITNESS:

1. 1. Signature .............................  Signature .............................
    2.  Name ...............................  Name (Executant) ...............
    3.  Address .............................  Designation ......................
       ( Authorised representative )

2. 1. Signature .............................
    2.  Name ...............................
    3.  Address .............................  Seal
FORM FOR GUARANTEE BOND
FOR ANTI-TERMITE TREATMENT

THIS AGREEMENT made this _____ day of Two thousand _____ between M/s _______ (hereinafter called the guarantor of the one part and M/s Engineering Projects (India) Limited, hereinafter called EPI hereinafter called the OWNER of the other part.

Whereas this agreement is supplementary to the contract hereinafter called the contract dated_______ made between the guarantor of the one part and Engineering Projects (India) Ltd., of the other part whereby the Contractor inter-alia, understood to render the buildings and structures in the said contract recited, completed, termite proof. And whereas the guarantor agreed to give a guarantee to the effect that the said structure will remain termite proof for TEN YEARS to be so reckoned from the date after the maintenance period prescribed in the contract expires.

During this period of guarantee the guarantor shall make good all defects and for that matter shall replace at his risk and cost such wooden member as may be damaged by termite and in case of any other defect being found, he shall render the building termite proof at his cost to the satisfaction of the Engineer-In-Charge and shall commence the works of such rectification within seven days from date of issuing notice from the Engineer-In-Charge calling upon him to rectify the defects falling which the work shall be got done by EPI/ OWNER by some other Contractor at the guarantor’s cost and risk and in the later case the decision of the Engineer-In-Charge as to the cost recoverable from the guarantor shall be final and binding.

That if the Guarantor fails to execute the Anti-Termite treatment or commits breaches hereunder then the Guarantor will indemnify EPI against all losses damages, cost expenses or otherwise which may be incurred by him by reasons of any default on the part of the guarantor in performance and observance of this supplemental Agreement. As to the amount of loss and or damage and/or cost incurred by EPI/ OWNER, the decision of the Engineer-In-Charge will be final and binding on the parties.

In witness where of these presents have been executed by the Guarantor_________ and by_______________ for and on behalf of EPI on the day of month and year first above written.

Signed sealed and delivered by (Guarantor)

IN THE PRESENCE OF:
1.

2.

Signed for and on behalf of EPI by/ in presence of:

1.

2.
GUARANTEE TO BE EXECUTED BY CONTRACTOR FOR REMOVAL OF DEFECTS AFTER COMPLETION IN RESPECT OF WATER PROOFING WORKS

The agreement made this ................. day of ................. Two thousand ..................
between ................................... (hereinafter called Guarantor of the one part) and EPI
(hereinafter called the Execution Agency of the other part).

WHEREAS this agreement is supplementary to a contract (hereinafter called the Contract), dated ............ and made between the GUARANTOR OF THE ONE part and EPI of the other part, whereby the Contractor, inter-alia, undertook to render the buildings and structures in the said contract recited completely water and leak proof.

AND WHEREAS the Guarantor agreed to give a guarantee to the effect that the said structures will remain water and leak proof for ten years from the date of handing over of the structure of water proofing treatment.

NOW THE GUARANTOR hereby guarantees that water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be ten years to be reckoned from the date after the maintenance period prescribed in the contract.

Provided that the Guarantor will not be responsible for leakage caused by earthquake or structural defects or misuse of roof or alteration and for such purpose.

a)  Misuse of roof shall mean any operation, which will damage proofing treatment, like chopping of firewood and things of the same nature, which might cause damage to the roof.

b)  Alternation shall mean construction of an additional storey or a part of the roof or construction adjoining to existing roof whereby proofing treatment is removed in parts

c)  The decision of the Engineer-In-Charge with regard to cause of leakage shall be final

During this period of guarantee, the Guarantor shall make good all defects and in case of any defect being found render the building water proof to the satisfaction of the Engineer-In-Charge at his cost and shall commence the work for such rectification within seven days from the date of issue of notice from the Engineer-In-Charge calling upon him to rectify the defects failing which the work shall be got done by EPI by some other Contractor at the guarantor's cost and risk. The decision of Engineer-In-Charge as to the cost, payable by the Guarantor shall be final and binding.

That if the Guarantor fails to execute the waterproofing or commits breach thereunder, then the Guarantor will indemnify the principal and his successors against all laws
damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and / or damage and/ or cost incurred by EPI, the decision of the Engineer-In-Charge will final and binding on the parties.

IN WITNESS WHEREOF these presents have been executed by the Obligor, ....... and by .......... And for and on behalf of EPI on the day, month and year first above written.

Signed, sealed and delivered by Obligor in the presence of-

1.

2.

Signed for and on behalf of EPI by ______________

In presence of:

1.

2.
AGREEMENT FORM

This agreement made this day of (Month) (Year), between THE ENGINEERING PROJECTS (INDIA) LIMITED (EPI), (A Govt. of India enterprise) a company incorporated under the Companies Act, 1956 having its Registered and Corporate Office at Core-3, Scope Complex, 7, Institutional area, Lodhi Road, New Delhi – 110003 (hereinafter referred to as the “EPI” which expression shall include its administrators, successors, executors and assigns) of the one part and M/s (NAME OF CONTRACTOR) (hereinafter referred to as the ‘Contractor’ which expression shall unless the context requires otherwise include its administrators, successors, executors and permitted assigns) of the other part.

WHEREAS, EPI, is desirous of construction of (NAME OF WORK) (hereinafter referred to as the “PROJECT”) on behalf of the (NAME OF OWNER/MINISTRY) (hereinafter referred to as “OWNER”), and had invited Tenders as per Tender Documents vide NIT No. _____.

AND WHEREAS (NAME OF CONTRACTOR) had participated in the above referred Tender vide their tender dated _____ and EPI has accepted their aforesaid Tender and award the contract for (NAME OF PROJECT) on the terms and conditions contained in its Letter of Intent No. ________ dated ________ and the documents referred to therein, which have been unequivocally and unconditionally accepted by (NAME OF CONTRACTOR) vide their Letter of Undertaking dated _______ resulting into a contract.

NOW THEREFORE THIS DEED WITNESSETH AS UNDER:

ARTICLE 1.0 – AWARD OF CONTRACT

1.1 SCOPE OF WORK

EPI has awarded the contract to (NAME OF CONTRACTOR) for the work of (NAME OF WORK) on the terms and conditions in its Letter of intent No. ________ dated ________ and the documents referred to therein. The award of work has taken effect from (DATE) i.e. the date of issue of aforesaid letter of intent. The terms and expressions used in this agreement shall have the same meanings as are assigned to them in the “Contract Documents” referred to in the succeeding Article.

ARTICLE 2.0 – CONTRACT DOCUMENTS

2.1 The contract shall be performed strictly as per the terms and conditions stipulated herein and in the following documents attached herewith (hereinafter referred to as “Contract Documents”).

a) EPI Notice Inviting Tender vide No. ________ date ________and EPI’s Tender Documents consisting of:

   i) Instructions to Tenderers and General Conditions of Contract (GCC) alongwith amendments/errata to GCC (if any) issued (Volume-I).
ii) Additional Conditions of Contract including Appendices & Annexures, Volume-II.

iii) Bill of Quantities alongwith amendments/corrigendum of schedule items, if any (Volume-III).

iv) Technical Specifications

v) Drawings

vi) ______________________________________________

b) (NAME OF CONTRACTOR) letter/proposal no._________________
dated ________ and their subsequent communication:

i) Letter of Undertaking of Tender Conditions dated ______________

ii) _____________________________________________________

iii) _____________________________________________________

2.2 EPI’s detailed Letter of Intent No. __________ dated _____ including Bill of Quantities. Agreed time schedule, Contractor’s Organisation Chart and list of Plant and Equipments submitted by Contractor.

2.3 All the aforesaid contract documents referred to in Para 2.1 and 2.2 above shall form an integral part of this Agreement, in so far as the same or any part thereof conform, to the Tender Documents and what has been specifically agreed to by EPI in its Letter of Intent. Any matter inconsistent therewith, contrary or repugnant thereto or deviations taken by the Contractor in its “TENDER” but not agreed to specifically by EPI in its Letter of Intent, shall be deemed to have been withdrawn by the Contractor without any cost implication to EPI. For the sake of brevity, this Agreement alongwith its aforesaid contract documents and Letter of Intent shall be referred to as the “Contract”.

ARTICLE 3.0 – CONDITIONS & CONVENANTS

3.1 The scope of Contract, Consideration, Terms of Payments, Advance, Retention Moneys, Taxes wherever applicable, Insurance, Agreed Time Schedule, Compensation for delay and all other terms and conditions contained in EPI’s Letter of Intent No. __________ dated _____ are to be read in conjunction with other aforesaid Contract Documents. The contract shall be duly performed by the Contractor strictly and faithfully in accordance with the terms of this contract.

3.2 The scope of work shall also include all such items which are not specifically mentioned in the Contract Documents but which are reasonably implied for the satisfactory completion of the entire scope of work envisaged under this contract unless otherwise specifically excluded from the scope of work in the Letter of Intent.

3.3 Contractor shall adhere to all requirements stipulated in the Contract documents.

3.4 Time is the essence of the Contract and it shall be strictly adhered to. The progress of work shall conform to agreed works schedule/contract documents and Letter of Intent.

3.5 This agreement constitutes full and complete understanding between the parties and terms of the presents. It shall supersede all prior correspondence to the extent of inconsistency or repugnancy to the terms and conditions contained in
Agreement. Any modification of the Agreement shall be effected only by a written instrument signed by the authorized representative of both the parties.

3.6 The total contract price for the entire scope of this contract as detailed in Letter of Intent is Rs. _________________ (Rupees _____________________________ only), which shall be governed by the stipulations of the contract documents.

ARTICLE 4.0 – NO WAIVER OF RIGHTS

4.1 Neither the inspection by EPI or the Engineer-In-Charge or Owner or any of their officials, employees or agents nor order by EPI or the Engineer-In-Charge for payment of money or any payment for or acceptance of, the whole or any part of the work by EPI or the Engineer-In-Charge nor any extension of time nor any possession taken by the Engineer-In-Charge shall operate as waiver of any provisions of the contract, or of any power herein reserved to EPI, or any right to damage herein provided, nor shall any waiver of any breach in the contract be held to be a waiver of any other or subsequent breach.

ARTICLE 5.0 – GOVERNING LAWS AND JURISDICTION

5.1 The Laws applicable to this contract shall be the laws in force in India and as amended from time to time.

Jurisdiction shall be of the Court (s) stated in the 'Memorandum' to the ‘Form of Tender’ only.

5.2 Notice of Default

Notice of default given by either party to the other party under the Agreement shall be in writing and shall be deemed to have been duly and properly served upon the parties hereto, if delivered against acknowledgment due or by FAX or by registered mail duly addressed to the signatories at the address mentioned herein above.

IN WITNESS WHEREOF, the parties through their duly authorized representatives have executed these presents (execution whereof has been approved by the Competent Authorities of both the parties) on the day, month and year first above mentioned at New Delhi.

For and on behalf of: For and on behalf of:

(NAME OF CONTRACTOR) M/s. Engineering Projects (I) Ltd.

WITNESS: WITNESS:

1. 1.

2. 2.
ENGINEERING PROJECTS (INDIA) LIMITED
(A Govt. of India Enterprise)

QUALITY CONTROL FORMATS AND CHECKLISTS
## CHECK LIST FOR CONCRETING

**NAME OF PROJECT**: 

**CONTRACT**: 

**CONTRACT No.**: 

**LOCATION BLOCK**: 

**FLOOR**: 

**AREA**: 

### LAYOUT
- Alignment: Checked
- Level of base: 
- Dimensional Check (edges & diagonals): 
- Stair Ecc: 
- Location of cutouts & services: 

### STAGING / SCAFFOLDING
- Adequacy & rigidity of Props, stays, bracings, conformity to scheme orgs.:

### FORMWORK
- Qty. of forms and support: 
- Props adequate: 
- Vertical form surface in alignment & plumb: 
- Even Surface Oil sprayed: 
- Gaps between shuttering are properly closed: 
- No space for sagging of Formwork: 

### REINFORCEMENT
- Cutting & bending as per Bar bending schedule (Schedules attached): 
- Adequate laps: 
- Chair / cover blocks: 
- Welds: 
- Chair / cover blocks: 
- Placed as per scheme: 
- Binding wire not touching shuttering: 
- Fixtures, inserts: 
- Dowels & positioning: Provided as per org.
- Walkway for: 
- Labour provided: 

**CLEARANCE from Elect In-charge**: 

### PRE-CONCRETING
- Concreting Arrangements: 
- Approval of Construction joint: 
- Mixer / vibrator: 
- Condition & mixing: 
- Top level of Concrete marked:
- Transporting & Placing arrangement:

### POST-CONCRETING
- Compaction: 
- Checked:
- Removal of Laitsance:
- Post Concreting: 
- Level/Dimensions:
- No. of Cubes Cast:

### DESSHUTTERING & CLEARING
- Curing days: 
- Water / compound:
- Surface finish: 
- Concrete Test Results OK:

### SIGNATURE

<table>
<thead>
<tr>
<th>W.O. ITEM</th>
<th>UNIT</th>
<th>QTY.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRACTOR</td>
<td>DATE</td>
<td>SITE ENGR</td>
</tr>
<tr>
<td>LAYOUT</td>
<td>CHECK LIST FOR MASONRY WORK</td>
<td>SCAFFOLDING</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Alignment &amp; wall</td>
<td></td>
<td>Adequacy of props,</td>
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<tr>
<td>Thickness Checked</td>
<td></td>
<td>Stays, platform</td>
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<td></td>
<td>Rigidity of base</td>
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<td></td>
<td>Movement Space</td>
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<td>Approach to height</td>
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<td></td>
<td>Bricks as per specification</td>
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<td></td>
<td>Mortar grade &amp; mix</td>
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<td>Bricks</td>
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<td>Joint alignment</td>
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<td>Vertical joints</td>
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<td>Properly mortar filled from top</td>
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<td>Raking of joints</td>
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<td>Bearing plaster for</td>
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<td></td>
<td>Concrete</td>
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<td>Proper curing of const.</td>
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<td>Joint</td>
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<th>W.O. ITEM</th>
<th>UNIT</th>
<th>QTY</th>
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<tr>
<td>CONTRACTOR</td>
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<td>SITE ENGR</td>
<td>DATE</td>
</tr>
<tr>
<td></td>
<td>SITE INCHARGE</td>
<td>DATE</td>
<td>CONSULTANT</td>
</tr>
</tbody>
</table>

NAME OF PROJECT ____________________________

REFERENCES No. ____________________________

LOCATION: BLOCK ________ FLOOR ________ AREA ________
### Check List for Plastering Work

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
<th>Status</th>
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<tbody>
<tr>
<td><strong>SCAFFOLDING</strong></td>
<td>Platform</td>
<td>Stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Movement space</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approach to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Height</td>
</tr>
<tr>
<td><strong>SERVICE</strong></td>
<td>All chasing work</td>
<td>Fixing in position</td>
</tr>
<tr>
<td></td>
<td>Complete</td>
<td>Using clamps etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patching</td>
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<td></td>
<td></td>
<td>Work complete</td>
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<tr>
<td></td>
<td></td>
<td>All door/window frames</td>
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<tr>
<td></td>
<td></td>
<td>Fixed in position</td>
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<tr>
<td></td>
<td></td>
<td>Skirting to floors marked</td>
</tr>
<tr>
<td></td>
<td><strong>CLEARANCE from Elect In-charge</strong></td>
<td></td>
</tr>
<tr>
<td><strong>SURFACE</strong></td>
<td>Clearing &amp; ranking of surface</td>
<td>Roughening</td>
</tr>
<tr>
<td><strong>PREPARATION</strong></td>
<td></td>
<td>Hacking done</td>
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<tr>
<td></td>
<td></td>
<td>Fixing metal/lathe</td>
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<tr>
<td></td>
<td></td>
<td>Chicken mesh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mortar level</td>
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<tr>
<td></td>
<td></td>
<td>Guides made</td>
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<tr>
<td></td>
<td></td>
<td>Surface moistened</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cement slurry</td>
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<tr>
<td><strong>PIASTERING</strong></td>
<td>Mix &amp; WP compound</td>
<td>Costing/thickness</td>
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<tr>
<td></td>
<td>Checked as per specification</td>
<td>As specified</td>
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<tr>
<td></td>
<td></td>
<td>Groove at Joints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provided</td>
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<tr>
<td></td>
<td></td>
<td>Corners/edges sharp</td>
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<td></td>
<td></td>
<td>&amp; at right Angles</td>
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<tr>
<td></td>
<td></td>
<td>lines &amp; levels maintained</td>
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<tr>
<td></td>
<td></td>
<td>Surface leveled with</td>
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<tr>
<td></td>
<td></td>
<td>At straight edge</td>
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<tr>
<td><strong>FINISHING</strong></td>
<td>Texture</td>
<td>Curing</td>
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<tr>
<td></td>
<td></td>
<td>Days.............</td>
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<tr>
<td></td>
<td></td>
<td>Site cleared</td>
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### Signature & Details

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<tr>
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<th>W.O. Item</th>
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<tr>
<td>Contractor</td>
<td>Date</td>
<td>Site Engr</td>
<td>Date</td>
</tr>
<tr>
<td>EXCAVATION</td>
<td>Lay</td>
<td>Slope/cutting as per Specifications</td>
<td>Level</td>
</tr>
<tr>
<td>LAYING/RCC</td>
<td>Bed concrete as per Specifications</td>
<td>RCC pipes as per Requirement</td>
<td>Jointing of Pipes</td>
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<tr>
<td>Boxing</td>
<td></td>
<td>Strata bore Dewatering (wherever required)</td>
<td></td>
</tr>
<tr>
<td>Manholes</td>
<td>Bricks as per specifications</td>
<td>Mortar as per specifications</td>
<td>Plastering</td>
</tr>
<tr>
<td>End of pipes plugged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back fillings</td>
<td>In layers</td>
<td></td>
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</table>

<p>| SIGNATURE | W.O. ITEM | UNIT | QTY |
| CONTRACTOR | DATE | SITE ENGR | DATE | SITE INCHARGE | DATE | CONSULTANT | DATE |</p>
<table>
<thead>
<tr>
<th>CONTRACT</th>
<th>CHECK LIST FOR GRIT WASH</th>
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</thead>
<tbody>
<tr>
<td>REF DRAWING No.</td>
<td>LOCATION BLOCK</td>
</tr>
<tr>
<td>CONTRACT No.</td>
<td>FLOOR</td>
</tr>
</tbody>
</table>

### SCAFFOLDING
- Platform
  - Stability
  - Movement space
  - Approach to Height

### SERVICE PROVISIONS
- All painting work Complete
- All door/window frames Fixed in position

### SURFACE PREPARATION
- Roughening/hamming of surface done
  - Fixing metal/lathe
  - Chicken mesh
  - Mortar level
  - Guides made
  - Surface moistened/cement slurry

### BASE PLASTER
- Mix & VFP compound
  - Checked against spec
  - Coating/thickness
  - As specified
  - Corners/edges sharp & at right Angles
  - Lines & levels maintained

### TOP LAYER
- Fixing of beading for grooves as per drawing
  - Lines and levels of grooves maintained
  - Mix as per specification
- Washing of top layer
  - Washing with Acid (light)
  - Curing day
  - Texture of final surface

### SIGNATURE
- W.O. ITEM | UNIT | QTY |
- CONTRACTOR | DATE | SITE ENGR | DATE | SITE INCHARGE | DATE | CONSULTANT | DATE |
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>Make as specified</th>
<th>Thickness / class as specified</th>
<th>Length &amp; dia as specified</th>
<th>No cracks or holes visible</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAYOUT</td>
<td>Space distribution &amp; Alignment as spec.</td>
<td>Plumb of vertical line checked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIXING PIPE &amp; FITTINGS</td>
<td>Qty available for pipes fittings &amp; jointing material as per size &amp; fixing</td>
<td>Cutting &amp; Jointing as specified</td>
<td>Fixing of fittings &amp; specials as specified</td>
<td>Connection with corr. internal networks</td>
</tr>
<tr>
<td>SMOKE TEST</td>
<td>Open ends plugged</td>
<td>Injection of smoke Pressure</td>
<td>No leakage of Smoke</td>
<td>Section is Ok</td>
</tr>
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| W.G. ITEM | UNIT | QTY. |

<table>
<thead>
<tr>
<th>CONTRACTOR</th>
<th>DATE</th>
<th>SITE ENGR</th>
<th>DATE</th>
<th>SITE INCHARGE</th>
<th>DATE</th>
<th>CONSULTANT</th>
<th>DATE</th>
</tr>
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</table>
**NAME OF PROJECT**

<table>
<thead>
<tr>
<th>CONTRACT</th>
<th>CHECK LIST FOR MOSAIC FLOORING</th>
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<tbody>
<tr>
<td>REF DRAWING No.</td>
<td>LOCATION BLOCK</td>
</tr>
<tr>
<td>CONTRACT No.</td>
<td></td>
</tr>
</tbody>
</table>

### LAYOUT
- **Sub base Prepared**
  - Provision of Services checked
  - Paneling (max size)
  - Level of Sub base checked
- **Slope**
  - Provision checked

### BASE LAYER
- **Mix As specified**
  - Water / cement
  - Slurry applied
  - Cement concrete
  - Thickness checked
  - Ramming / leveling
  - Compaction done
- **Evenness Checked**
  - Joints treatment
  - If any, provided

### TOP LAYER
- **Mix As specified**
  - Proper leveling
  - Done
  - Troweling finish
  - Proper
  - Curing done

### FINISHING
- **Grinding**
  - Final grinding
  - Repair applied at grinding stages
  - Polishing

**W.O. ITEM | UNIT | QTY.**

**SIGNATURE**

<table>
<thead>
<tr>
<th>CONTRACTOR</th>
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<th>DATE</th>
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<table>
<thead>
<tr>
<th>LAYOUT</th>
<th>Fixing pattern</th>
<th>Level of base &amp; dark height marked</th>
<th>Finish level guide</th>
<th>Door &amp; window frames in position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix</td>
<td>Thickness layers</td>
<td>Watering / cement slurry</td>
<td>Evenness</td>
<td>Vertically, corners at right angle</td>
</tr>
<tr>
<td>Moistening of tiles</td>
<td>Plan position of cut pieces at corner</td>
<td>Cut to size</td>
<td>Smooth edge</td>
<td>Chamfering of edges &amp; edge matching properly</td>
</tr>
<tr>
<td>Cement slurry adhesive</td>
<td>Level &amp; plumb checked</td>
<td>No hollow sound on tapping</td>
<td></td>
<td>Raking / Jointing</td>
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<tr>
<td>Finishing</td>
<td>Grounding of joints</td>
<td>Curing of joints</td>
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NAME OF PROJECT ____________________________
## NAME OF PROJECT

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<thead>
<tr>
<th>MATERIAL AGGREGATE</th>
<th>Gradation as specified</th>
<th>Crushing strength as specified</th>
<th>No of layers</th>
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<tr>
<td>SCREENINGS</td>
<td>Gradation as specified</td>
<td>Crushing strength as specified</td>
<td>waiting &amp; rolling as specified</td>
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<td>MOORUM</td>
<td>Gradation as specified</td>
<td>Silt content as specified</td>
<td>fill material</td>
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<tr>
<td>LAYOUT</td>
<td>Alignment of central line as per drawings and reference points</td>
<td>Marking of Carriage way edges as per drawings</td>
<td>Cross section levels of precedent Layer recorded</td>
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<tr>
<td>WATER BOUND MACADAM</td>
<td>Templates placed of specified thickness</td>
<td>Placing, leveling of stone aggregate</td>
<td>Stone Screening spread as specified</td>
</tr>
<tr>
<td></td>
<td>Dry rolling as specified</td>
<td>Application of moorum as specified</td>
<td>Wet rolling / compaction as specified</td>
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<tr>
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<th>QTY.</th>
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Instruction to Bidders (ITB)
e-procurement

1. **NOTICE INVITING BID AND OBTAINING BID DOCUMENTS:**

1.1. The authority belonging to the major discipline is competent to invite tender of composite bids. He will also nominate the Executive Engineer who will deal with all matters relating to the bids in the invitation of bids.

1.2. For composite tender, estimated cost of each component should be clearly indicated in addition to combined estimated cost put to tender. The eligibility of bidders will correspond to the combined estimated cost of different components put to tender.

1.3. The contractor shall comply with the provisions of the Apprentices Act 1961, and the rules/amendments issued there under from time to time. If he fails to do so, it will be considered a breach of the contract and the Superintending Engineer/Executive Engineer may at his discretion without prejudice to any other right or remedy available under law, cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation of the provisions of the said Act by him.

1.4. The contractor shall be deemed to have satisfied himself as to the correctness and sufficiency of the Tender and of the rates and prices quoted in the Bill of Quantities, all of which shall, except in so far as it is otherwise provided in the Contract, cover all his obligations under the Contract (including those in respect of the supply of goods, materials, plant & services or of contingencies for which there is a Provisional Sum) and all matters and things necessary for the proper execution and completion of the work and the remedying of any defects therein.

1.5. The successful bidder shall complete the works by the intended completion date specified in the Contract data.

1.6. Throughout these bidding documents, the terms “bid and tender” EMD and Bid Security and their derivatives (bidder / tenderer, bidding / tendering, etc.) are synonymous.

1.7. In case the tender for composite work includes in addition to main work / building work all other ancillary works such as sanitary and water supply installations, drainage installation, electrical work, Firefighting installation, horticulture work, roads and paths and gate works in dams and canals etc., the bidder apart from being a registered civil Contractor of appropriate class must associate himself with agencies of appropriate class those who is eligible to tender for sanitary and water supply drainage, electrical, Firefighting installation and horticulture works in the composite tender. Intending purchasers are not required to produce any documents viz. copy of Registration, GST Registration certificate & GSTIN etc, at the time of purchase of tender documents but will be required for verification purpose at later stage. Furnishing copy of such documents is mandatory along with the tender documents otherwise his/her bid shall be declared as non-responsive and thus liable for rejection. The L1 Bidder is required to attend the officer inviting the bid for **verification of original documents within five days** of opening the Price bid.

1.8. **PARTICIPATING IN THE BID IN THE E-PROCUREMENT PORTAL:** The Contractor/Bidder intending to participate in the bid is required to register in the Portal with some information about the firm/Contractor. This is a onetime activity for registering in Portal. During registration, the contractor has to attach a Digital Signature Certificate (DSC) to his/her unique user ID. The DSC used must be of appropriate class (Class II or Class III) issued from a registered Certifying Authority such as n-Code, Sify, TCS, MTNL e-Mudra etc.

1.8.1. To log on to the portal the Contractor/Bidder is required to type his/her **username** and password. The system will again ask to select the DSC and confirm it with the password of DSC. For each login, a user’s DSC will be validated against its date of validity and also against the Certificate Revocation List (CRL) of respective CAs stored in system database. The system checks the unique ID, password and DSC combination and authenticates the login process for use of portal.
1.8.2. The tender documents uploaded by the Tender Inviting Officer in the website www.tendersOdisha.gov.in will appear in the section of “Upcoming Tender” before the due date of tender sale. Once the due date has arrived, the tender will move to “Active Tender” section of the homepage. Only a small notification will be published in the newspaper specifying the work details along with mention of the specific website for details. The publication of the tender will be for specific period of time till the last date of submission of bids as mentioned in the ‘Invitation for Bid’ after which the same will be removed from the list of Active tenders. Any bidder can view or download the bid documents from the web site.

1.8.3. Contractor exempted from payment of EMD will be able to participate in the tender directly by uploading documentary evidences towards his eligibility for such exemption.

1.8.4. If the software application has the provision of payment of cost of tender document through payment gateways of authorized bankers by directly debiting the account of the bidders, bidders will be required to avail on-line payment.

1.9. The bidders are to participate in the bid on-line.

1.10. **DELETED.**

1.11. In the case of any failure, malfunction, or breakdown of the electronic system used during the e-procurement process, the tender inviting officer shall not accept any responsibility for failures or breakdowns other than in those systems strictly within their own control.

1.12. Any third party/company/person under a service contract for operation of e-procurement system in the State or his/their subsidiaries or their parent companies shall be ineligible to participate in the procurement processes that are undertaken through the e-procurement system irrespective of who operates the system.

2. **ELIGIBLE BIDDERS:**

2.1. This Bid is open to all Contractors of the class mentioned in the Invitation for Bids registered with the State Governments and Contractors of Equivalent Grade/Class Registered with Central Government/ MES/ Railways for execution of civil works. The Bidders are required to enclose the proof of registration from the registering authority along with the Bid subject only to the registration in the portal using his/her DSC for on-line bids.

Contractors not registered with Govt. of Odisha can participate in the e-procurement after necessary enrolment in the portal but have to subsequently register themselves with the appropriate registering authority of the state Govt. before award of the work as per prevalent registration norms of the state.

2.2. All bidders **shall** provide a statement that the bidder is neither associated, nor has been associated, directly or indirectly, with the Consultant or any other entity that has prepared the design, specifications, and other documents for the Project or being proposed as Project Manager for the Contract. A firm that has been engaged by the Engineer-in-Charge to provide consulting services for the preparation or supervision of the works, and any of its affiliates shall not be eligible to bid.

2.3. If the bidder has a relative employed as an Officer in the rank of an Assistant Engineer/Under Secretary and above in the Government of Odisha in the concerned Department, he shall inform the same in Schedule-I of the bid document mentioning the exact details in a covering letter along with the tender, failing which his bid will not be considered. Also if the fact of relationship subsequently comes to light, his contract will be rescinded. The bid security or the performance security will be forfeited and he shall be liable to make good any loss or damage resulting from such cancellation. In case the bidder has no relationship with any of the officers mentioned above he shall have to furnish with his bid an undertaking to that effect.

2.4. He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any gazetted officer in the concerned Department. Any breach of this condition by the contractor would render him liable for penal action for suppression of facts.
2.5. No Engineer of gazetted rank or other gazetted officer employed in Engineering or Administrative duties in an Engineering Department of the Government of Odisha is allowed to work for contractor for a period of two years after his retirement from Government service, without prior permission of the Government of Odisha in writing. Such a contract is liable to be cancelled if either the contractor or any of his employees is found any time to be such a person who had not obtained the permission of the Government of Odisha as aforesaid before submission of the tender for engagement in the contractor’s service.

3. QUALIFICATION CRITERIA:

3.1. For submission of Bids through the E-Procurement Portal, the bidder shall upload the scanned copy/copies of documents listed under clause 3.2 in prescribed format wherever warranted in support of eligibility criteria and qualification information. The L-1 bidder shall have to produce the original documents in support of the scanned copies and statements uploaded in the portal within 5 days of opening of price bid. The Bids from Joint ventures are not acceptable.

3.2. The bid shall include following information and documents.

(a) Copy of valid contractor’s registration certificate, PAN card, GST Registration certificate & GSTIN should accompany the technical bid.

(b) Copies of original documents defining the constitution or legal status, place of registration, and principal place of business; written power of attorney of the signatory.

(c) Major construction equipment to be deployed to carry out the Contract. The contractors are required to furnish evidence of ownership of principal machineries / equipments for only those machineries / equipments asked for in the tender documents.

(d) In case if contractor executing several works, he is required to furnish a time schedule for movement of equipment/machinery from different site to this work site when work is to be executed.

(e) The contractor shall furnish ownership documents for those machineries which he is planning to deploy for the tendered work.

(f) In case the contractor proposes to engage machineries and equipments as asked for in the tender document, owned or hired but deployed outside the state, he/she is required to furnish additional 1% EMD/Bid security.

(g) The contractor intending to use/lease equipment/machineries are required to furnish proof of ownership from the company/persons providing equipment/ lease deed and duration of such contract.

(h) Copy of sub-contract agreement with eligible Registered Electrical Contractors having valid L.T. / H.T. license (Associated with the sub-contractor).

(i) Details of work under progress as per tender documents.

(j) Details of works executed during the last five years and works in hand (list of on-going works as per bid documents).

(k) The bidder is required to furnish MOU with professional Firm or body having experience in handling Fire safety services for design, construction and commissioning High rise/ Old age home/ Buildings/ Hospitals / Apartments along with Registration certificate of Firm for Installation & Commissioning of Fire safety services

3.3. DELETED

3.4. The Bidders are subject to be disqualified if they have:

a. Made misleading or false representations in the forms, statements and attachments submitted in proof of the qualification requirements; and/or

b. Record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history, or financial failures etc.; and/or

c. Participated in the previous bidding for the same work and had quoted unreasonable prices and could not furnish rational justification to the Engineer-in-Charge.

d. Indulged in unlawful & corrupt means in obtaining bids.

e. Been black listed/their registrations by the competent authority.
4. **ONE BID PER BIDDER:**

4.1. Each bidder shall submit only one bid for one package. A bid is said to be responsive if accompanied by cost of bid document and appropriate bid security. The system shall consider only the last bid submitted through the E-Procurement portal.

5. **COST OF BIDDING:**

5.1. The bidder shall bear all costs associated with the preparation and submission of his bid, and the Engineer-in-Charge will in no case be responsible and liable for those costs.

5.2. All the rates and prices in the bid shall cover all taxes, GST Registration certificate & GSTIN, ferry, tollage charges and royalties and any other charges except GST.

5.3. The rate of royalties and taxes prevailing on the date of measurement shall be considered while making deductions in the bills.

5.4. The successful bidder shall make his own arrangement for all materials unless otherwise specified in the conditions of contract.

6. **SITE VISIT:**

6.1. Bidders are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their tenders as to the nature of the ground and sub-soil (so far as practicable), the form and nature of the site, the means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their bid. A Bidder shall be deemed to have full knowledge of the site whether he inspects it or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed. The Bidder shall be responsible for arranging and maintaining at his own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by a bidder implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and of conditions and rates at which tools and plant, etc. will be issued to him by the Government and local conditions and other factors having a bearing on the execution of work.

6.2. The bidder, in preparing the bid, shall rely on site Investigation Reports referred to in the Contract Data, supplemented by any information available to the bidder.

6.3. The Officer inviting the bid / Engineer-in-Charge will clarify queries on the Contract Data on requisition by the intending Bidder. The bidder may ask question in the e-procurement portal using his DSC; provided the questions are raised before the date mentioned in the home page under critical dates.

7. **GENERAL INSTRUCTIONS:**

7.1. The description of the work is as mentioned under Invitation for Bid.

7.2. The bids uploaded by the Tender Inviting Officer may consist of general arrangements drawings or typical sections of the project. Bidder may download these drawings and take out the print for detail study. Any other drawings and documents pertaining to the works available with the officer inviting the Bid as well as in the office of the Executive Engineer as mentioned in the contract data will be open for inspection during working hours on all working days by the bidders. The bidder is required to down-load all the documents including the drawings for preparation of his bid. It is not necessary on the part of the Bidder to up-load the drawings other Bid documents (after signing) while up-loading his bid. He is required to up load documents related to his qualification information and Bill of Quantities duly filled in. It is assumed that while participating in the bid, the bidder has referred to all the drawings and documents uploaded by the Officer Inviting the Bids. Seeking any revision of rates or backing out of the bid claiming for not having referred to any or all documents provided in the Bid document by the Officer Inviting the Bids will be construed as plea to disrupt the bidding process and in such cases the bid security shall be forfeited.

**B. BIDDING DOCUMENTS**

7.1. The description of the work is as mentioned under Invitation for Bid.

7.2. The bids uploaded by the Tender Inviting Officer may consist of general arrangements drawings or typical sections of the project. Bidder may download these drawings and take out the print for detail study. Any other drawings and documents pertaining to the works available with the officer inviting the Bid as well as in the office of the Executive Engineer as mentioned in the contract data will be open for inspection during working hours on all working days by the bidders. The bidder is required to down-load all the documents including the drawings for preparation of his bid. It is not necessary on the part of the Bidder to up-load the drawings other Bid documents (after signing) while up-loading his bid. He is required to up load documents related to his qualification information and Bill of Quantities duly filled in. It is assumed that while participating in the bid, the bidder has referred to all the drawings and documents uploaded by the Officer Inviting the Bids. Seeking any revision of rates or backing out of the bid claiming for not having referred to any or all documents provided in the Bid document by the Officer Inviting the Bids will be construed as plea to disrupt the bidding process and in such cases the bid security shall be forfeited.
7.3. The bidder is expected to examine carefully all instructions, conditions of contract, contract data, forms, terms, and technical specifications, bill of quantities, forms, Annexes and drawings in the Bid Document. Failure to comply with the requirements of Bid Documents shall be at the bidder’s own risk.

8. CLARIFICATION OF BIDDING DOCUMENTS:

8.1. Bid documents consisting of drawings, plans, specifications, the schedule of quantities of the various items of work to be done and the set of terms & conditions of contract to be complied with by the contractor who intends to bid and other necessary Documents can be seen in the office of the officer inviting the Bid during office hours every day except on Sundays & Public Holidays till last date of sale of tender paper.

8.2. No paper copy of the bid shall be sold.

8.3. The Contract Data to bid shall be filled and completed in the office of Officer inviting bid before issue of bid documents. If the documents are issued to the intending bidder without having been so filled in & completed, he shall request the officer inviting the bid to have this done before he completes and delivers his bid.

8.4. The bidder can seek clarification on the bids which he received earlier than 15 days prior to the deadline for submission of bids. The Employer’s response will be forwarded through the e-mail ID of the enquirer.

8.5. PRE-BID MEETING: DELETED

9. AMENDMENT OF BIDDING DOCUMENTS:

9.1. Before the deadline for submission of bids, the officer inviting the Bid may modify the bidding documents by issuing addenda.

9.2. Any addendum thus issued shall be part of the bidding documents and shall be notified in the website www.tendersOdisha.gov.in / notice board and through paper publication.

9.3. To give prospective bidders reasonable time in which to take an addendum into account in preparing their bids, the Officer inviting the Bid if also happens to be the Engineer-in-Charge with the permission of the higher authority may, at his discretion, extend as necessary the dead line for submission of bids.

C. PREPARATION OF BIDS

10. LANGUAGE OF THE BID:

10.1. All documents relating to the Bid shall be in the English / Hindi / Oriya language. Bids submitted in any other language shall be summarily rejected.

11. DOCUMENTS COMPRISING THE BID:

11.1. Following documents will be deemed to be part of the bid even if not submitted with the bid.

(i) Invitation for Bids (IFB)
(ii) Instructions to bidders (ITB)
(iii) Conditions of Contract
(iv) Contract Data
(v) Specifications
(vi) Drawings

11.2. All the volumes/documents shall be provided in the portal by the Officer inviting the bid. The bidder shall carefully go through the document and prepare the required documents and up load the scanned documents in Portable Document Format to the portal in the designated locations of Technical Bid. He will fill up the percentage rate in the BOQ down loaded for the work in designated Cell and up-load the same in designated locations of Financial Bid. Submission of document shall be effected by using DSC of appropriate class.

A. Cost of “Bid document” & “Bid Security” shall be remitted online using e-procurement Gateway
B. “Technical Bid” shall comprise.
(i) Declaration under the Official Secret Act, 1923
(ii) Qualification Information and supporting documents,
(iii) Certificates, undertakings, affidavits,

C. “Financial Bid” shall comprise.
(i) Priced Bill of Quantities

12. PROPOSAL BY THE BIDDER:
12.1. In the E-Procurement Portal, an intelligent Bill of Quantity in Microsoft Excel format shall be made available to the bidder.

12.2. For **Item rate** tenders, the bidder shall fill in rates in figures and should not leave any cell blank. The line item total in words and the total amount shall be calculated by the system and shall be visible to the bidder.

12.3. In case of **percentage rate** tender, the bidder will only fill in the designated cell and activate “less” or “excess” to indicate how much his price offer is excess or less (**Up to two decimal Place**) than the estimated amount.

12.4. The **bidder** shall bid for the whole works as described in the Bill of Quantities.

12.5. Bidders shall submit offers that fully comply with the requirements of the bidding documents, Including the Conditions of Contract basic technical design as indicated in the drawing and specification. **Conditional offer or alternative offers will not be considered** in the process of bid evaluation.

12.6. All duties, taxes, excluding GST including Building and other Construction Workers Welfare Cess @ 1% payable by the contractor under the contract, or for any other cause shall be included in the rates, prices submitted by the bidder. Taxes on material in respect of this contract shall be payable by the Contractor and Government will not entertain any claim whatsoever in respect of the same except GST payable for works contract.

12.7. In the case of any bid where unit rate of any item/items appear unrealistic, such bid will be considered as unbalanced and in case the bidder is unable to provide satisfactory explanation such a tender is liable to be disqualified and rejected.

12.8. Bidders while quoting their offers shall consider the following as regards price adjustment towards **Cement, Steel & Bitumen** and escalation of all components of work as per Sub-Clause 31 of Condition of P-1 Contract.

12.9. Deleted.

12.10. Deleted.

12.11. Deleted.

12.12. Deleted

12.13. The contractor shall be deemed to have satisfied himself as to the correctness and sufficiency of the Tender and of the rates and prices stated in the Bill of Quantities, all of which shall, except in so far as it is otherwise provided in the Contract, cover all his obligations under the Contract (including those in respect of the supply of goods, materials, plant & services or of contingencies for which there is a **Provisional Sum**) and all matters and things necessary for the proper execution and completion of the work and the remedying of any defects therein.

12.14. The **contractor shall** conform in all respects, by giving all notices and paying all fees, with the provisions of:
   i) Any national or State Statue, Ordinance, or other Law, or any regulation, or bye-law of any local or other duly constituted authority in relation to the execution and completion of the works and remedying of any defects therein, and
   ii) The rules and regulations of all public bodies and companies whose property rights are affected or may be affected in any way by the works.
12.15. **FOR COMPOSITE BIDS; DELETED.**

13. **CURRENCIES OF BID AND PAYMENT:**

13.1. The unit rates and the prices shall be quoted by the bidder entirely in Indian Rupees. All payments shall be made in Indian Rupees.

14. **VALIDITY:**

14.1. Bids shall remain valid for a period not less than **90 days** or the period mentioned in the Contract Data, after the deadline date for submission of bid as specified in the notice inviting the Bids. A Bid valid for a shorter period shall be rejected by the Engineer-in-charge as non-responsive.

14.2. In exceptional circumstances, prior to expiry of the original time limit, the Officer inviting the Bid may request the bidders to extend the period of validity for a specified additional period. The request and the bidders’ responses shall be made in writing or by cable or by e-mail.

14.3. **DELETED.**

15. **BID SECURITY:**

15.1. The Bidder shall remit a bid security for the amount mentioned under Contract Data.

The successful lowest bidder will produce the original of all scanned documents for verification within 5 days of opening of the tender (Price Bid). In the eventuality of failure on the part of the lowest successful bidder to produce the original documents, he will be debarred in future from participating in tender for three years and will be blacklisted by the competent authority. In such a situation, successful L-2 bidder will be required to produce his original documents for consideration of his/her tender at the negotiated rate equal to L-1 bidder.

15.1.1. **DELETED**

15.1.2. **DELETED.**

15.1.3. **DELETED**

15.2. The Bid shall be declared non-responsive and shall be rejected if submitted without an acceptable Bid Security and not secured as indicated in Sub-Clauses 15.1.

15.3. Combined bid security for more than one work is not acceptable.

15.4. In the case of Government Undertakings, Co-operatives Societies, Diploma or Degree holders in Engineering who are registered with the Government of Odisha, the rules framed by government from time to time about Cost of Bid documents, Bid security, performance security will apply.

15.5. The bid Security of unsuccessful bidders will be returned within 28 days of the end of the validity period specified in Sub-Clause 14.1.

15.6. The Bid Security of the successful bidder will be discharged when the bidder has signed the Agreement and furnished the required Performance Security and Additional Performance security if any.

15.7. The Bid Security may be forfeited

15.7.1. If the bidder withdraws the bid after opening of the bid but within the period of validity.

15.7.2. If the Bidder seeks any revision of rates or backs out of the bid claiming for not having referred to any or all documents provided in the Bid by the Officer Inviting the Bids.

15.7.3. **DELETED.**

15.7.4. In the case of a successful bidder, if the bidder fails within the specified time limit to

15.7.4.1. Sign the Agreement; or

15.7.4.2. Furnish the required Performance Security including additional performance security if any.
16. **FORMAT AND SIGNING OF BID:**

16.1. The bidder can download the tender of his choice and save it in his system and undertake the necessary preparatory work off-line and upload the completed tender at his convenience within the final date and time of submission. The bidder shall only submit single copy of the required documents and Price Bid in the portal. In the Financial bid, the bidder cannot leave any figure blank. He has to only write the figures, the words will be self-generated. The Bidders are advised to upload the completed Bid document well ahead of the last date & time of receipt to avoid any last moment problem of power failures etc.

16.2. The Bidder shall go through the Bid carefully and list the documents those are asked for submission. He shall prepare all documents including cost of Bid Document, Bid Security, Declaration form, price bid etc and store in the system.

16.3. The bidder shall log on to the portal with his DSC and move to the desired tender for uploading the documents in appropriate place one by one simultaneously checking the documents. Once the Bidder makes sure that all the documents have been up-loaded in appropriate place, he clicks the submit button to submit the bid to the portal.

16.3.1. Tender cannot be pre-opened and cannot be submitted after due date and time. Therefore, only after satisfying that all the documents have been uploaded, the Bidder should activate submit button.

16.3.2. In the e-procurement process, each process is time stamped. The system can identify each individual who has entered into the portal for any bid and the time of entering into the portal.

16.3.3. The Bidder should ensure clarity of the document uploaded by him to the portal, especially the scanned documents by taking out sample printing. Non-submission of legible documents may render the bid non-responsive. However, the Officer inviting the Bids if so desires, can ask for legible copies for clarification within a stipulated period of 7 days, provided such document in no way alters the Bidder's price bid. If the Bidder fails to submit such documents with in the stipulated date, his bid shall be evaluated on it's own merit.

D. SUBMISSION OF BIDS

17. **SECURITY OF BID SUBMISSION:**

17.1. All bid data uploaded by the Bidder to the portal will be encrypted by the DSC of the opener(s). The system shall require all the mandatory forms and fields filled up by the contractor during the process of submission of the bid/tender.

17.2. The Bid shall be received in encrypted format by the system which can only be decrypted / opened by the authorized openers only on or after the due date and time.

18. **DEADLINE FOR SUBMISSION OF THE BIDS :**

18.1. The online bidding will remain active till the last date and time of the bid submission. Once the date and time (Server date and time) is over, the bidder will not be able to submit the bid. The date & time of bid submission shall remain unaltered even if the specified date for the submission of bids declared a holiday for the Officer inviting the Bid.

18.2. The officer inviting the bid may extend the deadline for submission of bids by issuing an amendment in accordance with Sub-Clause 9.3, in which case all rights and obligations of the officer inviting the bid & Engineer-in-Charge and the bidders previously subject to the original deadline will then be subject to the new deadline.

19. **LATE BIDS :**

19.1. The system shall reject submission of any bid through portal after closure of the receipt time. For all purpose the server time displayed in the e-procurement portal shall be the time to be followed by the bidder and concerned officers.

20. **MODIFICATION AND WITHDRAWAL OF BIDS :**
20.1. In the E-Procurement Portal, it is allowed to modify the bid any number of times before the final date and time of submission. The bidder shall have to log on to the system and resubmit the documents as asked for by the system including the price bid. In doing so, the bids already submitted by the bidder will be removed automatically from the system and the latest bid only will be admitted. But the bidder should avoid modification of bid at the last moment to avoid system failure or malfunction of internet or traffic jam or power failure. If the bidder fails to submit his modified bids within the designated time of receipt, the bid already in the system shall be taken for evaluation.

20.2. In the E-Procurement Portal, withdrawal of bid is allowed. But in such case he has to write a letter with appropriate reasons for his withdrawal addressed to the Officer inviting the bid and upload the scanned document to portal in the respective bid before the closure of receipt of the bid. The system shall not allow any withdrawal after expiry of the closure time of the bid.

E. OPENING AND EVALUATION

21. OPENING OF THE BID:

21.1. Bid opening dates are specified during tender creation or can be extended vide corrigendum. These dates are available in IFB, tender document as well as the home page of portal. Bid opening can be done by the authorized users which are defined during the tender publication / approval stage. The bids are encrypted using their public keys and can be decrypted only on or after the Bid Opening due date. The bid openers private key will be required to open the bids and all the openers have to log on to the portal during that time.

21.1.1. The bidders who participated in the online bidding can witness opening of the bid from any system logging on to the portal with the DSC away from opening place. Contractors are not required to be present during the bid opening at the opening location if they so desire.

21.1.2. Each activity is date and time stamped with user details. For time stamping, server time is taken as the reference.

21.2. In the event of the specified date of bid opening being declared a holiday for the Officer inviting the Bid/Engineer-in-Charge, the bids will be opened at the appointed time on the next working day.

21.3. In case bids are invited for more than one package, the order for opening of the “Bid” shall be that in which they appear in the “Invitation for Bid”.

21.4. The Bid openers; who have been pre-defined shall log on to the portal with their respective DSC. Unless all the Officers who have been declared as Opening officers, log on the portal with their DSC the Tender cannot be opened.

21.4.1. After receipt of confirmation of the bid security, the bidder will be asked in writing to clarify his technical bid, if necessary.

21.4.2. The bidders will respond in not more than 7 days of issue of the clarification letter, which will also indicate the date, time and venue of opening of the Financial Bid.

21.4.3. Immediately on receipt of these clarifications, the Evaluating Officers; predefined in the system for the bid, will finalize the list of responsive bidders. They will log on to the site with their DSC and record their comments on the Technical evaluation page in the system. The Officer Inviting the Bid if also the accepting authority, shall log on to the system with his digital signature and check the technical evaluation. He can either accept or pass on to the evaluating officers for re-evaluation. Upon acceptance of technical evaluation by the Accepting authority in the system, the system shall automatically generate letter to all the responsive bidders and the system shall forward the letter to all the responsive bidder that their technical bid has been evaluated responsive with respect to the data/information furnished by him and the letter shall also intimate him the date & time of opening of financial bid. The system shall also inform the non-responsive bidders in their email ID that their bid has been found non-responsive.
21.5. The Technical evaluation of all the bids will be taken up as per the information furnished by the Bidders. If any of the information/statements/documents/certificates furnished by the bidder is found to be false/fabricated/bogus, his EMD/Bid Security shall stand forfeited and his registration in the portal shall be blocked and the bidder is liable to be blacklisted.

21.6. After **technical** evaluation of the bidders and selection of the qualified bidders, the financial bids of the technically qualified bidders shall be opened on the due date of opening. Members of the bid opening committee log on to the system in sequence and open the financial bids for the technically qualified bidders. The opening of financial bid by the opening officer using their DSC shall decrypt the financial bids.

21.6.1. Opening of price bid and evaluation of lowest bidder is subject to satisfaction of other qualification information asked for in the bid pursuant to Clause-3.

21.6.2. The Officer inviting Bid shall ensure that all the Bidders are individually intimated about the date, time & venue of opening of the financial bid along with the responsiveness of the Technical Bid.

21.6.3. The Financial Bid will be opened on the notified date & time in the presence of bidders or their authorized representative who wish to be present.

21.6.4. At the time of opening of “Financial Bid”, the names of the bidders whose bids were found responsive in accordance with Sub-Clause 24.1 will be announced. The bids of only those bidders will be opened. The remaining bids will be rejected.

21.6.5. The responsive bidders’ names, the bid prices, the item wise rates the total amount of each item, any discounts and withdrawals, and such other details as the officer inviting the tender may consider appropriate, will be announced by him or his authorized representatives at the opening.

21.6.6. Special conditions and/or rebate/discount offer if any uploaded to the system shall be declared and recorded first.

21.6.7. The Financial bid of the bidders shall be opened one by one by the designated officers. **The system shall auto-generate the Comparative statement.**

21.6.8. The Bidder can witness the principal activities and view the documents/summary reports for that particular work by logging on to the portal with his DSC from anywhere.

22. **PROCESS TO BE CONFIDENTIAL:**

22.1. Information relating to the examination, clarification, evaluation, and comparison of bids and recommendations for the award of a contract shall not be disclosed to bidders or any other persons not officially concerned with such process until the award to the successful bidder has been announced. Any effort by a bidder to influence the officer inviting the bid, processing of bids or award decisions may result in the rejection of his bid.

23. **CLARIFICATION OF BIDS:**

23.1. To assist in the examination, evaluation, and comparison of bids, the officer inviting the bid may, at his discretion, ask any bidder for clarification of his rates including breakdowns of unit rates. The request for clarification and the response shall be in writing or by cable or by e-mail, but no change in the bid price or substance of the bid shall be sought, offered.

23.2. Subject to sub-clause 23.1, no bidder shall contact the officer inviting the bid on any matter relating to his bid from the time of the opening to the time the contract is awarded. If the bidder wishes to bring additional information to the notice of the officer inviting the bid, it should do so in writing.

24. **EXAMINATION OF BIDS AND DETERMINATION OF RESPONSIVENESS:**

24.1. During the detailed evaluation of “Technical Bids”, the officer inviting the bid will determine whether each bid:

24.1.1. Whether the Bid security is confirmed by issuing institution/bank.

24.1.2. Has submitted legible documents for evaluation
24.1.3. Meets the eligibility criteria defined in Clause 3 and;

24.1.4. Is substantially responsive to the requirements of the bidding documents.

24.2. During the detailed evaluation of the "Financial Bid", the responsiveness of the bids will be further determined with respect to the remaining bid conditions, i.e., priced bill of quantities, technical specifications and drawings.

24.3. A substantially responsive “Financial Bids” is one, which conforms to all the terms, conditions, and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one

24.3.1. Which affects in any substantial way the scope, quality, or performance of the works?

24.3.2. Which limits in any substantial way, inconsistent with the bidding documents, the right of the officer inviting the bid or the bidder’s obligations under the contract or

24.3.3. Whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

24.4. If a “Financial Bid” is not substantially responsive, it will be rejected by the officer inviting the bid, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

24.5. On opening of the price bid the system shall arrange the financial bids in order of their value (L1 first, followed by L2, L3 ….) for subsequent evaluation. The evaluation status (Sheet) will be visible to all the participating bidders after opening on their respective logins. Each activity is recorded in the system with date and time stamping.

25. **EVALUATION OF BIDS: DELETED**

25.1. If the officer inviting the Bid in his opinion judges that the price quoted by the lowest qualified bidder is high or a special condition imposed by the bidder is to be withdrawn, the bidder shall be invited for negotiation by the officer inviting the Bid or by an officer authorised by him in writing. **Negotiations** of financial bid with **only the lowest bidder** shall be carried out, if necessary. Negotiation of bid will be carried out by manual way.

25.2. **DELETED.**

25.3. **DELETED**

25.4. **DELETED.**

25.5. **DELETED.**

**F. AWARD OF CONTRACT**

26. **AWARD CRITERIA:**

26.1. The officer inviting the bid will award the contract to the bidder whose bid has been determined to be substantially responsive to the bidding documents and who has offered the lowest evaluated price.

26.2. On acceptance of the tender, the Contractor shall name in writing his accredited representative(s) who would be responsible for taking instructions from the Engineer-in-Charge.

26.3. Competent Authority on behalf of Governor of Odisha reserves to himself the right of accepting the whole or any part of the bid and the bidder shall be bound to perform the same at the rate quoted.

26.4. The successful bidder registered under other State Government / MES / Railways / CPWD in equivalent rank has to register under state PWD before signing of the agreement.

27. **OPTIONS IF THE BIDDER BACKS OUT FROM BIDDING PROCESS :**

27.1. In case the 1st lowest Bidder or even the next lowest Bidder withdraw in series one by one, thereby facilitating a particular Bidder for award, then they shall be penalized with adequate disincentives with forfeiture of EMD/Bid Security unless adequate justification for such back out is furnished. Appropriate action for blacklisting the bidder shall also be taken apart from dis-incentivising the bidder.
27.2. The bidding process shall be deemed to be complete till the date of issue of letter of acceptance. If the bidder fails to sign the agreement within the stipulated period mentioned under clause 29.2, his bid security shall stand forfeited.

28. **RIGHT TO ACCEPT OR REJECT ANY OR ALL BIDS**:

28.1. The competent authority on behalf of the Governor of Odisha does not bind him to accept the lowest or any other tender and reserves to him the authority to reject any or all the tenders received without assigning any reason.

28.2. All bids in which any of the prescribed condition is not fulfilled or any condition including that of conditional rebate is put forth by the bidder shall be summarily rejected.

29. **NOTIFICATION OF AWARD AND SIGNING OF AGREEMENT**:

29.1. In the E-Procurement Portal, the system shall generate the template of award letter and the Officer Inviting the Bid shall mention the amount of Performance Security and additional security required to be furnished in the letter and intimate the bidders in his e-mail ID. The issue of the letter of acceptance shall be treated as closure of the Bid process and commencement of the contract.

29.2. The bidder shall within 15 days of issue of letter of acceptance, furnish the Performance security & additional Performance security (if any) in the prescribed form & the work programme & shall sign the agreement in prescribed format, failing which the Engineer-in-Charge shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the Bid Security absolutely. The agreement will incorporate all agreements between the officer inviting the bid and the successful bidder.

If L1 bidder does not turn up for agreement after finalization of the tender, then he shall be debarred for participation in bidding for three years and action will be taken to blacklist the contractor. In that case, the L2 bidder, if fulfills, other required criteria would be called for drawing agreement for execution of work subject to the condition that L2 bidder negotiates at par with the rate quoted by the L1 bidder otherwise the tender will be cancelled. In case a contractor is black listed, it will be widely published and intimated to all departments of Government and also to Govt. of India agencies working in the state.

(Amendment to Para-3.5.14 Note-I of OPWD Code Vol.-I by inclusion).

29.2.1. Following documents shall form part of the agreement.

29.2.1.1. The notice inviting bid, all the documents including additional conditions, specifications and drawings, if any, forming the bid as issued at the time of invitation of bid and acceptance thereof together with any correspondence & documents leading thereto & required amount of performance security including additional performance security as per sub clause 29.2 hereof.

29.2.1.2. Standard Bid Document P.W.D. Form P-1

29.3. The letter to proceed with the work shall be issued by Engineer-in-charge only after signing of the agreement. The notification of award will constitute the formation of the contract subject only to the furnishing of performance security and additional performance security in accordance with the provisions of the agreement.

29.4. On acceptance of the composite bids by the competent authority the letter of award will be issued by the Engineer-in-Charge of the major component of the work on behalf of the Governor of Odisha.

29.5. Upon signing of the agreement by the successful bidder, the Engineer-in-Charge will promptly notify the other bidders that their bids have been unsuccessful.

30. **CORRUPT OR FRAUDULENT PRACTICES**:

30.1. The Engineer-in-Charge will reject a proposal for award if he determines that the bidder recommended for award has been engaged in corrupt or fraudulent practices in competing for the contract in question. He will report to the Officer Inviting Bid / next higher authority.

30.2. Canvassing whether directly or indirectly, in connection with tenders is strictly prohibited and the tenders submitted by the contractors who resort to canvassing will be liable for rejection.
DETAILED TENDER CALL NOTICE

1. Sealed percentage rate bids are invited online in double cover system from the Class of eligible contractors registered with the State Government and contractors of equivalent Grade / class registered with Central Government / MES / Railways having registration for Civil, Electrical and P.H. works for execution of Civil / E.I. / P.H. works on production of definite proof from the appropriate authority in prescribed firm to be eventually drawn in P.W.D. FORM P-1 for the work “Construction of Teaching Hospital for the new Govt. Medical college at Balasore, Odisha (500 bedded teaching Hospital, Service block, Medical gases pipeline system, ESS building, External works)” at an estimated cost of ₹148,19,00,471/- (Rupees One hundred Forty-Eight Crore Nineteen lakh Four Hundred Seventy-one) only (Excluding GST). Contractors not registered with Govt. of Odisha can participate in the e-procurement after necessary enrolment in the portal but have to subsequently register themselves with the appropriate registering authority of the state Govt. before award of the work as per prevalent registration norms of the state.

   a) This tender is of composite nature and consisting of Civil works, Electrical and PH works.

   b) This detailed Tender Call Notice along with the clauses mentioned herein shall form a part of the contract and agreement.

2. The Bid documents are available on official website of Government: https://www.tendersodisha.gov.in from dt.12.03.2019 to 17:00 hours of dt.02.04.2019. The last date and time of submission of Bid is as per contract data.

3. The Technical Bid documents (Cover–I) will be opened by the assigned officer in the office of the Engineer-in-Chief (Civil), Odisha, Bhubaneswar at 11.30 Hours on dt.04.04.2019 in the presence of the bidders or their authorized representatives who wish to attend. After evaluation of the documents contained in Cover-I, the Cover-II containing price bid/s of the technically responsive bidder/s will be opened. The date, time and place of opening the price bid will be intimated to the eligible qualified bidders through system generated E-mails.

4. The cost of Bid documents is to be remitted online through e-payment gateway for ₹10,000/- towards the paper cost of each bid respectively.

5. The bid is to be submitted in two covers.

   i) **Cover-I** is to contain scanned copy of Contractor Registration Certificate, GST Registration Certificate, GSTIN, PAN, Profit Loss statement, M.O.U. (Memorandum of Understanding duly notarized) with eligible registered electrical contractor having valid H.T. / L.T. license, List of similar nature of works, work in hand, list of machineries, affidavit, and all other documents required as per the relevant clauses of this DTCN. The contractor belonging to outside state of Odisha and not started business should submit an undertaking in the form of an Affidavit indicating therein that they are not registered under Odisha GSTIN as they have not started any business in the state and they have no liability under the Act. But before award of final contract, such bidders will have to produce the Odisha GSTIN.

   ii) **Cover-II** is to contain the PRICE BID duly filled in and signed by the bidder and scanned copy of Additional Performance Security as per the relevant clauses of this DTCN.

6. Furnishing scanned legible copy of Original Contractor Registration certificate, valid GSTIN, PAN card along with the Technical Bid is mandatory otherwise his/ her bid shall be declared as non responsive and thus liable for rejection.

7. **(i)** The Contractors are required to furnish scanned copy of evidence of ownership showing the possession of principal machineries/equipments as per Annexure-I in Schedule-C for which contractor shall have to secure minimum 80% of marks failing which the tender shall be liable for rejection.

   **(ii)** Incase the contractor proposes to engage machineries and equipments as asked for in the tender document, owned or hired but deployed outside the State has to mobilize the machineries within a period as to be able to execute an item of work as per original programme which will be part of the agreement.
(iii) The contractor intending to hire/lease equipments/machineries are required to furnish proof of ownership from the company/person providing equipments/machineries on hire/lease along with contracts/agreements/lease deed and duration of such contract. The contracts/agreements/lease deed should be on long term basis for a minimum period of 33 (Thirty-three) months as mentioned in contract data from the last date of receipt of Bid documents.

8. A) The civil contractor in order to take part in the composite tender should enter into an M.O.U. (Memorandum of Understanding duly notarized) with eligible registered electrical contractor having valid H.T. / L.T. license; for execution of electrical installation and other electrical works and a copy of such M.O.U. should be attached with the tender as per the proforma at Schedule- J which shall form a part of tender. A copy of electrical license should also be enclosed with the tender papers, the original of which need to be furnished during verification. The above M.O.U. is not required in case of the civil contractor having valid registration in H.T. / L.T. electrical license with the same name & style.

B.) Prequalification criteria for Fire Protection services & Scope of services such as Design, Supply, installation, testing, commissioning for fire protection works are given below.

1. Bidders shall make MOU with a professional firm or body who has competence and experience in installation of fire safety services of high rise buildings.
2. The said firm must have registered under any state Govt. / Central Govt. Organization for installation & commissioning of Fire Safety services, the certificate in support of these are to be furnished.
3. The firm must have executed at least one similar work costing not less than Rs.123.00 Lakhs / 2 or 3 work not less than Rs.41.00 lakhs aggregating to Rs.123.00 lakhs during Current / last five Financial years under Govt. / Semi Govt./ Reputed Private Sectors in support of which, certificate to this effect should be furnished from an officer not below the rank of E.E or equivalent.

C.) Prequalification criteria for Air Conditioning System & Scope of services such as Design, Supply, installation, testing, commissioning for HVAC work given below.

1. Bidders shall make MOU with a professional firm or body who has competence and experience in installation of HVAC (Chiller System) of high rise buildings.
2. The said firm must have registered under any state Govt. / Central Govt. Organization for installation & commissioning of HVAC (Air Conditioning), the certificate in support of these are to be furnished.
3. The firm must have executed at least one similar work costing not less than Rs.423.00 Lakhs / 2 or 3 work not less than Rs.141 lakhs aggregating to Rs.423.00 lakhs during Current / last five Financial years under Govt. / Semi Govt./ Reputed Private Sectors in support of which, certificate to this effect should be furnished from an officer not below the rank of E.E or equivalent.

9. (i) The contract will be drawn in P.W.D. P-1 contract form and will constitute 3 parts as follows.
   a. Part – I : For Civil items of works
   b. Part – II : For Electrical items of works
   c. Part – III : For PH items of works

The contract shall be drawn & signed by E.E., Balasore (R&B) Division No.-II, Balasore on behalf of the Governor of Odisha.

(ii) The Civil items of works as per Part-I of Schedule of quantities, Electrical items of works (both internal & external) as per part-II of Schedules of quantities and P.H. items of works (both internal & external) as per Part-III of the Scheduled of quantities of the Agreement shall be supervised measured and check measured by the E.E., Balasore (R&B) Division No.-II, Balasore, E.E., Balasore (R&B) Division No.-II, Balasore and Executive Engineer, General Public Health Division No-I, Bhubaneswar respectively. In the interest of expeditious execution of work, payment of interim bills (Running A/c bills) shall be made by the Executive Engineers of G.P.H. Division No-I, Bhubaneswar
in respect of Public Health works and nil final bill shall be sent to the concerned E.E., Balasore (R&B) Division No.-II, Balasore for final adjustment and compilation of accounts.

E.E., Balasore (R&B) Division No.-II, Balasore and G.P.H. Division No-I, Bhubaneswar shall be responsible for proper and timely execution of their respective items of works and implementation of the terms and condition of the contract. The contractor shall be bound to receive and act as well according to the direction of the Engineer-in-Charge for General Electrical / General Public Health Authority concerned.

10. If an individual makes the application, the individual should sign (with DSC) above his full type written name and current address.

11. If the application is made by proprietary firm, it shall be signed (with DSC) by the proprietor & furnish full type written name and the full name of his firm with its current address in a forwarding letter.

12. If the application is made by a firm in partnership, it shall be signed (with DSC) by a partner holding power of attorney for the firm in which case a certified copy of the power of attorney shall accompany the application. A certified copy of the partnership deed and current address of all partners of the firm shall also accompany the application.

13. If the application is made by a limited company or a corporation, it shall be signed (with DSC) by a duly authorized person holding power of attorney for signing the application in which case a certified copy of the power of attorney shall accompany the application. Such limited company or corporation will be required to furnish satisfactory evidence of its existence along with the technical bid.

14. The tender should be strictly in accordance with the provisions as mentioned in the tender schedule. Any change in the wordings will not be accepted.

15. The work is to be completed in all respects within Thirty (30) calendar months from the date of issue of work order. Before acceptance of tender, the successful bidder will be required to submit a work programme and milestone basing on the financial achievement so as to complete the work within the stipulated time and in case of failure on the part of the agency to achieve the milestone liquidated damage will be imposed

(Amendment to Para-3.5.18 Note-VIII of OPWD Code Vol.-I).

16. All tenders received will remain valid for a period of 90 days from the last date prescribed for receipt of tenders and validity of tenders can also be extended if agreed by the tenderers and the Department.

17. The tenderer shall carefully study the tentative drawings and specifications applicable to the contract and all the documents, which will form a part of the agreement to be entered in to, by the accepted tenderer and detailed specifications for Odisha, and other relevant specifications and drawings, which are available. Complaint at a future date that the tenderers have not seen plans and specifications cannot be entertained.

18. The drawings furnished with the tender are tentative and subject to revision or modification as tendered during the execution as per actual necessity and detail test conducted. But the tendered rates quoted by the tenderer will hold good in case of such modification of drawings during the time of execution and shall in no way invalidate the contract and no extra monetary compensation will be entertained. The work shall however be executed as per final approved drawing to be issued by the Engineer-in-Charge as and when required.

19. By admission of a tender for the work, a tenderer will be deemed to have satisfied himself by actual inspection of the site and locality of the work, about the quality and availability of the required quantity of material including the wheat/ rice referred to above, medical aid, labour and food stuff etc., and that rates quoted by him in the tender will be adequate to complete the work according to the specifications attached there to and that he had taken in to account all conditions and difficulties that may be encountered during its progress and to have quoted rates including labour and materials with taxes, octroi, other duties, lead, lifts, loading and unloading, freight for all materials and all other charges necessary for the completion of the work, to the entire satisfaction of the Engineer-in-Charge of the work and his authorized subordinates. After acceptance of the contract rate
Government will not pay any extra charges for any reason in case the contractor claims later on to have misjudged as regard availability of materials, labour and other factors.

For the purpose of estimate, the approved quarry lead is to be provided judiciously. Engineers in charge would be responsible for ensuring the quality of the materials supplied. The contractors would, however, be responsible for procurement of material from authorized sources and voluntarily disclose the source of procurement for the purpose of billing. Besides, the bidder would be required to submit the details of quarry for procurement while submitting the bids.

(Amendment to Para-3.4.16 (a) (vii) of OPWD Code Vol.-I by substitution).

20. The bidders shall remit the EMD / Bid Security amount @ 1% (One percent) of the estimated cost put to tender of ₹1,48,19,00,471/- rounded to thousand rupees i.e. ₹1,48,20,000/- (Rupees One Crore Forty-eight lakh Twenty thousand) only through Online as part of the bid. The Bid Security should remain valid minimum of 45 (Forty-five) days beyond the bid validity period.

21. The tender should be accompanied with the Scanned copies of the valid Contractor Registration certificate, GST Registration Certificate, GSTIN and PAN card which are mandatory, otherwise his/her bid shall be declared as non-responsive and thus liable for rejection. The contractor belonging to outside state of Odisha and not started business should submit an undertaking in the form of an Affidavit indicating therein that they are not registered under Odisha GSTIN as they have not started any business in the state and they have no liability under the Act. But before award of final contract, such bidders will have to produce the Odisha GSTIN.

22. The tender containing extraneous conditions not covered by the tender notice are liable for rejection and quotations should be strictly in accordance with the items mentioned in the Tender Call Notices. Any change in the wording will not be accepted.

23. The department reserves the right of authority to reject any or all tenders received without assigning any reason whatsoever.

24. The earnest money of the L-1 bidder will be retained and will be dealt with as per terms and condition of O.P.W.D. Code. The retention of E.M.D. with the Department will carry no interest.

25. The Engineer-in-charge will notify the bidder / tenderer whose bid has been accepted of the award prior to expiration of the validity period by cable, telex or facsimile confirmed by registered letter. This letter (hereinafter and in the conditions of Contract called the “Letter of Acceptance”) will state the sum that the Engineer-in-charge will pay the contractor in consideration of the execution, completion and maintenance of the Works by the contractor as prescribed by the contract (Hereinafter and in the contract called the “Contract Price”).

The Notification of award will constitute the formation of the contract, subject only to the furnishing of a performance security (Initial Security Deposit) in shape of Kissan Vikash Patra / Post Office Saving Bank Account / National Saving Certificate / Post Office Time Deposit Account / Bank Guarantee in favour of the Executive Engineer, Balasore (R&B) Division No.-II, Balasore, from any Nationalized / scheduled Bank in India counter guaranteed by its local branch at Bhubaneswar as per terms and conditions laid down in OGFR and in no other form. (As per O.M No.14468 dtd.20.09.2018 of Works Deptt Govt of Odisha), which shall be 2% of the value of the tendered amount and sign the agreement in the P.W.D. form No. P-1 (Schedule XLV No. 61) for the fulfillment of the contract in the office of the Executive Engineer, Balasore (R&B) Division No.-II, Balasore. The security deposit and the amount withheld according to the provision of P-1 agreement shall be retained as security for the due fulfillment of this contract and additional performance security in accordance with the provisions of the agreement.

The agreement will incorporate all agreements between the officer inviting the bid/ Engineer-in Charge and the successful bidder within 15 days following the notification of award along with the Letter of Acceptance. The successful bidder will sign the agreement and deliver it to the Engineer-in Charge. Following documents shall form part of the agreement.

a) The notice-inviting bid, all the documents including additional conditions, specifications and drawings, if any, forming the bid as issued at the time of invitation of bid and acceptance
thereof together with any correspondence leading thereto & required amount of performance security including additional performance security.

b) Standard P.W.D. Form P-1 with latest amendments. Failure to enter in to the required agreement and to make the security deposit as above shall entail forfeiture of the Bid Security (earnest money). No contract (tender) shall be finally accepted until the required amount of initial security money is deposited. The security will be refunded after 12 (Twelve) months of completion of the work and payment of the final bill and will not carry any interest. As concurred by Law Department & Finance Department In their U.O.R. No 848, dt.21.05.97 J.O.R.No.202 W.F.D. dt.06.03.98 respectively the E.M.D. will be forfeited in case, where tenderers back out from the offer before acceptance of tender by the competent authority.

26. The contractor should be liable to fully indemnify the Department for payment of compensation under workmen compensation act. VIII of 1923 on account of the workmen employed by the contractor and full amount of compensation paid will be recovered from the contractor.

27. Tenderers are required to liable by fair wages clause as introduced by Govt. of Odisha, Works Department letter No.VII (R&B) 5225, dt.26.2.55 and No.II, M-56/61-28842 (5), dt.27.9.61.

28. The contractor shall bear cost of various incidentals, sundries and contingencies necessitated by work in full within the following or similar category.

a) Rent, royalties, cess and other charges of materials and all other taxes including GST from time to time, Ferry tolls, conveyance charges and other cost on account of land buildings including temporary building required by the tenderer for collection of materials, storage, housing of staff or other purpose of the work are to be borne by the contractor at his own cost. No rent will be payable to Govt. for temporary occupation of land owned by govt. at the site of the work for bonafide use of the land for work and all such construction of temporary nature by the contractor shall be done after obtaining written permission from the Engineer-in-Charge of the work and all such construction shall have to be demolished and debris removed and ground made good and cleared after completion of the work at no extra cost.

b) Royalty will be recovered from each bill as notified by Govt. from time to time unless K Forms are enclosed. Refund of royalty at later date after passing of the bills cannot be entertained as the recovery of royalty is being credited to revenue.

c) Labour camps or huts necessary to a suitable scale including conservancy and sanitary arrangements therein to the satisfaction of the local labour laws and health authorities shall have to be provided by the Contractor.

d) Arrangement of suitable water supply including pipe water supply where available for the staff and labour as well as for the execution of the work is sole responsibility of the Contractor and no extra cost for carriage of water will be entertained. e) All fees and dues levied by Municipal, Canal or Water Supply Authorities are to be borne by the Contractor.

f) Suitable safety equipments and dresses, gloves, life belts etc. for the labour engaged in risky operations are to be supplied by the contractor at his own cost.

g) Suitable fencing barriers, signals including paraffin and electric signals where necessary at work and approaches in order in project the public and employees from accident has to be provided by the Contractor at his own cost.

h) Compensation including cost of any legal suit for injury to persons or property arising out of execution of the work and also any sum, which may become payable due to operation of the workmen compensation act, shall have to be borne by the contractor.

i) The contractor has to arrange adequate lighting arrangements for the work wherever necessary at his own cost.

29. No payment will be made for layout, benchmark, level pillars, profiles and benching and leveling the ground required, which has to be carried out by the contractor at his own cost. The rates to be quoted should be for finished items of work inclusive of carriage of all materials and all incidental items of work.
30. After the work is finished all surplus materials should be removed from the site of work, preliminary work such as vats, mixing platforms, etc. should be dismantled and all materials removed from the site and premises left neat and his should be inclusive in the rates. No extra payment will be made to the Contractor in this account.

31. It should be understood clearly that no claim what-so-ever will be entertained to extra items of works quantity of any item besides estimate amount unless written order is obtained from the competent authority and rate settled before the extra items of work or extra quantity of any items of work is taken up.

32. The tenderers shall have to abide by the C.P.W.D. safety code rules introduced by the Govt.of India, Ministry of Works and Housing & Supply in their standing order No.44150, dt.25.11.57.

33. No part of the contract shall be sublet without written permission to the concerned Executive Engineer or transfer to be made by the power of attorney authorizing others to receive payment on contractor’s behalf.

34. Bid documents consisting of plans, specifications, the schedule of quantities and the set of terms and conditions of contract and other necessary documents can be seen in all the offices issuing the documents and office of the under signed during office hours every day except on Sundays and Public Holidays till last date of sale and receipt of tender papers. Interested bidders may obtain further information at the same address. But it must be clearly understood that tenders must be received in order and according to instructions in complete shape. Incomplete tender is liable for rejection.

35. **No Relation certificate.**

   The contractor shall furnish a certificate along with the tender to the effect that he is not related to any officer in the rank of an Assistant Engineer & above in the state P.W.D. or Assistant/Under Secretary & above in the Works Department. If the fact subsequently proved to be false, the contract is liable to be rescinded. The earnest money & the total security will be forfeited & he shall be liable of make good to damages the loss or damages resulting for such cancellations. The proforma for no relationship certificate is contained in a separate sheet vide **Schedule-A**.

36. **Payment for variation in price -**

   Contract price shall be adjusted for increase or decrease in rates and price of Labour, Cement, Steel, Bitumen, Pipes, POL & other material component in accordance with the following principles and procedures as per formula Vide Works Department Memorandum No-12606 /W dt.24.12.2012 as given below :

   31.(a)(i) **REIMBURSEMENT / RECOVERY DUE TO VARIATION IN PRICE OF MATERIALS OTHER THAN (STEEL, CEMENT, BITUMEN, PIPES & P.O.L.).**

   If during the progress of the work the price of any materials (Excluding the cost of steel, cement, bitumen & P.O.L.) incorporated in the work (not being materials supplied from the Engineer-in-Charge’s store) in accordance with clause there of increases or decreases as a result of increase or decrease in the Average wholesale price Index (all commodities), and the contractor there upon necessarily and properly pays in respect of that materials incorporated in the work such increased or decreased price, then he shall be entitled to reimbursement or liable to refund, quarterly as the case may be, such an amount, as shall be equivalent to the plus or minus difference of 85% in between the Average Wholesale price Index (all commodities) which is operating for the quarter under consideration and that operated for the quarter in which the bid was received (last date of receipt) as per the formula indicated below provided that the work has been carried out within the stipulated time or extension thereof as are not attributable to him. If penalty is levied for delayed completion of the work, the contractor shall not be eligible to get price escalation on the above materials on the value of works executed during the extended period.

   This clause will be applicable to the contracts where original stipulated period of completion is more than 18 months.
In the situation where the period of completion is initially stipulated in the agreement as less than 18 (eighteen) months but subsequently the completion period has been validly extended on the ground that the delay in completion is not attributable to the contractor and in the result the total period including the extended period stands more than 18 (eighteen) months or more, price escalation for other materials is admissible only for the remaining period excluding 18 (eighteen) months there from.

**Formula to calculation the increase or decrease in the price of materials:**

Price adjustment for increase or decrease in cost of materials other than cement, steel, bitumen, pipes and POL procured by the contractor shall be paid in accordance with the following formula:

\[ V_m = 0.85 \times P_m / 100 \times R \times (M_i - M_o) / M_o \]

- \( V_m \) = Increase or decrease in the cost of work during the quarter under consideration due to changes in rates of materials other than cement, steel, bitumen, pipes and POL.
- \( R \) = Value of work done during the quarter under consideration excluding the work executed under extra items if any at prevailing schedule of rate / derived rates.
- \( M_o \) = The all India wholesale price index (all commodities) prevailed during the quarter of last date of receipt of bids (as published by the Economic Adviser to Govt. of India, Ministry of Industry and Commerce, New Delhi).
- \( M_i \) = The all India wholesale price index (all commodities) for the quarter under consideration as published by Economic Adviser, Govt. of India Ministry of Industry and Commerce, New Delhi. In respect of the justified period extended for completion of the work, the index prevailing at the time of stipulated date of completion or the prevailing index of the period under consideration, whichever is less, shall be considered.
- \( P_m \) = Percentage of material component (other than cement, steel, bitumen, pipes and POL) of the work, as indicated in clause-31 (d) below.

31.(a)(ii) **REIMBURSEMENT / RECOVERY OF DIFFERENTIAL COST DUE TO VARIATION IN PRICES OF PRINCIPAL MATERIALS (STEEL, CEMENT, BITUMEN, PIPES) NOT ISSUED BY DEPARTMENT, AFTER SUBMISSION OF TENDER:**

If after submission of the tender, the prices of Steel, Cement, Bitumen and Pipes (not being supplied by the Department) increases / decreases beyond the price(s) prevailing at the time of the last date of submission of tenders including extension for the work, the contractor shall be eligible to get differential cost due to such hike on the value of works executed during the stipulated period and during the extended period when the reason of delay in completion of the work is not attributable to the Contractor. If penalty is levied for delayed completion of the work, the contractor shall not be eligible to get price variation on the above materials on the value of works executed during the extended period.

Reimbursement in case of differential cost due to increase in prices of cement, steel, bitumen and pipes are to be made by the Executive Engineer with prior approval of tender accepting authority subject to following conditions:

1) Contractors have to submit the vouchers showing procurement of different materials from authorized dealers for the said work.

2) Differential cost will be allowed only for the works which are progressed as per the approved work programme / revised work programme duly approved by the Engineer in charge.

Recovery in case of decrease in prices of cement, steel, bitumen and pipes shall be made by concerned Executive Engineer from the Contractor immediately.
The increase / decrease in prices of cement, steel, Bitumen and Pipes for reimbursement / recovery shall be determined as follows:

a) **Adjustment towards differential cost of cement**

\[ V_c = \frac{(C_i - C_o)}{C_o} \times \text{Actual quantity of cement utilized in the work during the quarter under consideration} \times \text{base price of cement as prevailing on the last stipulated date of receipt of tender including extension, if any.} \]

\[ V_c = \text{Differential cost of cement i.e. amount of increase or decrease in rupees to be paid or recovered.} \]

\[ C_i = \text{All India wholesale price index for cement for the quarter under consideration as published by Economic Adviser, Govt. of India, Ministry of Industry and Commerce, New Delhi.} \]

\[ C_o = \text{All India wholesale price index (as published by Economic Adviser, Govt. of India, Ministry of Industry and Commerce, New Delhi) for cement as prevailing on the last stipulated date of receipt of tender.} \]

b) **Adjustment towards differential cost of Steel**

\[ V_s = (S_i - S_o) \times \text{Actual quantity of steel utilized in the work during the quarter under consideration.} \]

\[ V_s = \text{Differential cost of steel i.e. amount of increase or decrease in rupees to be paid or recovered.} \]

\[ S_i = \text{Cost of the steel as prevailed during the period under consideration as fixed by Steel Authority of India.} \]

\[ S_o = \text{Base price of Steel prevailing as on the last date of submission of tender including extension, if any.} \]

c) **Adjustment towards differential cost of Bitumen**

\[ V_b = (B_i - B_o) \times \text{Actual quantity of bitumen utilized in the work during the quarter under consideration.} \]

\[ V_b = \text{Differential cost of Bitumen i.e. amount of increase or decrease in rupees to be paid or recovered.} \]

\[ B_i = \text{Average cost of Bitumen prevailed during the period under consideration as fixed by IOCL / BPCL / HPCL.} \]

\[ B_o = \text{Base price of bitumen as prevailing on the last stipulated date of receipt of tender including extension, if any.} \]

d) **Adjustment towards differential cost of Pipes.**

\[ V = 0.85 \times \frac{P_p}{100} \times R \times \frac{(P_i - P_o)}{P_o} \]

\[ V_p = \text{Differential cost of pipe i.e. amount of increase or decrease in rupees to be paid or recovered during the quarter under consideration.} \]

\[ P_p = \text{Percentage of pipe component of the work as indicated in the clause-31(d).} \]

\[ R = \text{Value of work done during the quarter under consideration excluding the value of work executed under extra items, if any, at prevailing schedule of rates or derived rate.} \]

\[ P_i = \text{All India Wholesale price index for the period under consideration as published by Economic Advisor, Govt. of India, Ministry of Industry and Commerce, New Delhi, for the type of pipe under consideration.} \]

\[ P_o = \text{All India Wholesale price index (as published by Economic Advisor, Govt. of India, Ministry of Industry and Commerce, New Delhi) as on the last stipulated date of receipt of tender including extension, if any for the type of pipe under consideration.} \]

31.(b) **REIMBURSEMENT / REFUND DUE TO STATUTORY RISE IN COST OF MINIMUM WAGES BY GOVERNMENT:**
If after submission of the tender, the wages of labour increases or decreases as a direct result of the coming into force of any fresh law, or statutory rule or order beyond the wages prevailing at the time of the last date of submission of tenders including extensions, the contractor shall be eligible to get escalation due to such hike on the value of works executed during the stipulated period and during the validity extended period when the delay in completion is not attributable to the Contractor. If penalty is levied for delayed completion of the work, the contractor shall not be eligible to get escalation on labour on the value of works executed during the extended period.

The contractor shall, within a reasonable time of his becoming aware of any alteration in the price of any such wages of labour, give notice thereof to the Engineer-in-Charge stating that the same is given pursuant to this condition together with all information relating thereto which he may be in a position to supply. Engineer-in-Charge may call books of account and other relevant documents from the contractor to satisfy himself about reasonability of increase in prices of wages and actual payment thereof. For this purpose, the labour component of the work executed during period under consideration shall be the percentage (as specified in table below) of the value of work done during that period and the increase / decrease in labour shall be considered on the cost of minimum daily wages of any unskilled labourer, fixed by the Government of Odisha under Minimum wages act.

The compensation for escalation for labour shall be worked out as per the formula given below:

\[ V_l = \frac{0.85 \times P_l}{100 \times R \times (L_i - L_o)} / L_o \]

\[ V_l = \text{increase or decrease in the cost of work during the quarter under consideration due to changes in rates of minimum wages.} \]

\[ R = \text{Value of work done during the quarter under consideration excluding the work executed under extra items if any at prevailing schedule of rate / derived rates.} \]

\[ L_o = \text{The minimum wages for labour as notified by State Government, as prevailing on the last stipulated date of receipt of tender including extension, if any.} \]

\[ L_i = \text{The minimum wages for labour as notified by the State Government & as prevailed on the last date of the quarter previous to the one under consideration. In respect of the justified period extended, the minimum wage prevailing on the last date of quarter previous to the quarter pertaining to stipulated date of Completion or the minimum wage prevailing on the last date of the quarter previous to the one under consideration, whichever is less, shall be considered.)} \]

\[ P_l = \text{Percentage of labour component of the work, as indicated in the clause 31 (d)} \]

31.(c) REIMBURSEMENT / REFUND DUE TO VARIATION IN PRICES OF P.O.L. :

Similarly, if during the progress of work, the prices of Diesel, Petrol, Oil and Lubricants increases or decreases as a result of the price fixed thereof by the Government of India and the Contractor thereupon necessarily and properly pays such increased or decreased price towards Diesel, Petrol, Oil and Lubricants used in the execution of the work, then he shall be entitled to reimbursement or liable to refund, quarterly, as the case may be such an amount as shall be equivalent to the plus or minus difference of 85% in between the price of P.O.L., which is operating for the quarter under consideration and that operated for the quarter of last date of receipt of bids as per the formula indicated below provided that the work has been carried out within the stipulated time or extension thereof as are not attributable to him. If penalty is levied for delayed completion of the work, the contractor shall not be eligible to get price escalation on POL on the value of works executed during the extended per.

Formula to calculate the increase or decrease in the price of P.O.L.:
\[ V_f = 0.85 \times P_f / 100 \times R \times (F_i - F_o) / F_o \]

Increase or decrease in the cost of work during the quarter under consideration due to changes in rates for P.O.L.

\[ P_f = \text{Percentage of P.O.L. component of the work, as indicated in the clause 31 (d) below.} \]

\[ R = \text{Value of work done during the quarter under consideration excluding the work executed under extra items if any at prevailing schedule of rate / derived rates.} \]

\[ F_i = \text{All India Wholesale price index for Fuel, Oil and Lubricant (High Speed Diesel) for the quarter under consideration as published by Economic Adviser, Govt. of India, Ministry of Industry And Commerce, New Delhi.} \]

In respect of the justified period extended, the rates prevailing at the time of stipulated date of completion or the prevailing rates of the period under consideration, whichever is less, shall be considered.

\[ F_o = \text{All India Wholesale price index for Fuel, Oil and Lubricant (High Speed Diesel) as prevailing on the last stipulated date of receipt of tender including extension, if any.} \]

31.(d) The following percentages will govern the price adjustment for the entire contract for different types of works as applicable given in the following table:

**Percentage Table**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Category of works</th>
<th>% Component (cost wise)</th>
<th>Labour (P_l)</th>
<th>POL (P_f)</th>
<th>Steel + Cement + Bitumen + Other Materials *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>R&amp;B works (% of component)</td>
<td>Road works</td>
<td>5</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Bridge works</td>
<td>25</td>
<td>5</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building works</td>
<td>25</td>
<td>-</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Irrigation works (% of component)</td>
<td>Structural work</td>
<td>20</td>
<td>5</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Earth, Canal &amp; Embankment work</td>
<td>25</td>
<td>10</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>P.H. Work</td>
<td>Structural work</td>
<td>25</td>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Pipeline works</td>
<td>5</td>
<td>-</td>
<td>Pipe – 70%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sewer Line</td>
<td>10</td>
<td>-</td>
<td>pipe – 70%</td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Further break up may be worked out considering the consumption of Cement, Steel, Bitumen and Pipe in the concerned works for the period under consideration.

31.(e) APPLICATION OF ESCALATION CLAUSE:

i) The contractor shall for the purpose of availing reimbursement / refund of differential cost of steel, bitumen, cement, pipe, POL and wages, keep such books of account and other documents as are necessary to show that the amount of increase claimed or reduction available and shall allow
inspection of the same by a duly authorized representative of Government and further, shall at the request of the Engineer-in-charge, furnish documents to be verified in such a manner as the Engineer-in-charge may require any document and information kept. The contractor shall within a reasonable time of 15 days of his becoming aware of any alteration in the price of such material, wages of labour and / or price of P.O.L. give notice thereof to the Engineer-in-charge stating that the same is given pursuant to this condition along with information relating thereto which he may be in a position to supply.

ii) The compensation for escalation shall be worked out at quarterly intervals and shall be with respect to the cost of work done as per bills during the three calendar months on the said quarter. The first payment shall be made at the end of three months after the month (excluding the month in which tender was accepted) and thereafter at three months interval. At the time of completion of the work, the last period for payment might become less than 3 months, depending on the actual date of completion.

37. If any advance / Secured advance is granted by the Department the same will bear interest at the rate of 18% P.A.

38. All items of work as per schedule of quantities of this tender should confirm to Odisha Detailed Standard Specification. I.R.C. & I.S.I. Codes & Bridge code section I,II,III,IV&VII & latest design criteria for pre-stressed concrete bridge specially for Roads & Bridges issued by MoRT&H., Government of India, Compacting shall have to be carried out with help of mechanical vibrators from the range of I.S.:2505, I.S.:2006, I.S.:2514. I.S.:4656.

39. Centering & Shuttering shall be with suitable steel shutters in side of which shall be lined with suitable sheeting and made leak proof and watertight. All joints in formwork shall be properly sealed preferably with P.V.C. joints sealing tapes & compounds.

40. Form work including complete false work shall be designed by the Contractor without any extra cost to employer and the Department will have the right to inspect the scaffolding, centering and shuttering made for the work and can reject partly or fully such structures, if found defective in their opinion. Any eventually such as loss of lives or properly due to failure of centering and shuttering shall be the responsibility of the Contractor regarding compensation of all claims thereof.

41. Cement shall be used by bags and weight of one bag of Cement should be 50 (fifty) Kg. net & the Engineer-in-Charge or his representative shall have the right to test the weight & quality from time to time.

42. The tenderers shall make all arrangements for proper storage of materials but no cost for raising shed for store and pay of security guard etc. will be borne by the Department. The department is not responsible for any theft or loss of materials at site. It is contractor's risk. Under any such plea, if the tenderer stops the work he shall have to pay the full penalty as per clauses of the contract.

43. Approach road to site of work for transport of materials to site of work is sole responsibility of the Contractor. Statutory traffic restriction in the town area for Transport of construction material to site of work is to be taken in to consideration before tendering and no consideration for extra time or compensation thereof shall be considered.

44. The contractor should at his own cost arrange necessary tools and plants required for efficient execution of work and the rates quoted should be inclusive of transportation, hire and running charges of such plant and cost of consumables.

45. The contractor shall properly co-ordinate with the execution of P.H. and Electrical works and take care of the safety of workers.

46. The machineries if available, with the department may be supplied on hire as per charges noted in the enclosed statement and may be changed from time to time subject to the condition that the contractor will execute in advance an agreement with the Engineer-in-Charge.

47. No claim whatsoever will be entertained for supply of machineries. No extension of time will be granted to the contractor under this ground under any circumstances.
48. The tenderer should furnish along with their tender a list of works executed during the last five years duly certified by the concerned Engineer-in-charge indicating the satisfactory completion for Civil, P.H. & Electrical works as per the proforma enclosed in a separate sheet of Schedule-D.

49. The tenderer or any of its constituent partners of whose contract for any work has been rescinded or who has abandoned any work in the last five years prior to the date of Bid shall be debarred from qualification. The tenderer is to furnish an affidavit at the time of submission of tender paper about the authentication of tender documents. An affidavit to this effect is to be furnished in Schedule-F and information in Schedule-E.

50. It should be clearly understood that:
   a) The joints of the bars are to be provided with lapping, welds or bolts nuts as well be directed by the Engineer-in-charge.
   b) Concrete test specimens 150mm x 150mm x 150mm in size (whether plain or reinforced concrete) for the testing shall be taken for each structural member by a representative of the contractor in the presence of responsible officer of the rank not lower than that of an Assistant Engineer or sub-Divisional Officer. The contractor shall bear the cost so involved in testing. The test specimen in cube should be carried out in the Departmental Control and Research Laboratory of Cuttack or Bhubaneswar. Test should be carried out in accordance with the stipulation in Bridges code section-III.
   c) Test specimens shall be formed carefully in accordance with the standard method of taking test specimen and no plea shall be entertained later on the grounds that the casting of the test specimen was faulty and that the result of the specimen did not give a correct indication of the actual quality of concrete.
   d) Plain concrete and reinforced concrete specimens will be tested in Quality Control and Research Laboratory as per direction of Engineer-in-charge. Cost of testing of all specimens and samples will be borne by the Contractor.

51. The rates quoted should be inclusive of carriage of water required in connection with execution of the work. No claim for carriage of water whatsoever will be entertained.

52. The contractor shall employ one or more Engineering Graduate or Diploma holders as apprentice at his cost if the work as shown in the tender exceeds ₹2,50,000.00. The apprentices will be selected by the Chief Engineer. The period of employment will commence within one month after the date of work order and would last till the date, when 90% of the work is completed. The fair wage to be paid to the apprentices should not be less than the emolument of personnel of equivalent qualification employed under Government. The number of apprentices to be employed should be fixed by the Chief Engineer in the manner so that the total expenditure does not exceed one percent of the tendered cost of the work.

53. List of tool & plants in running condition in possession of contractor is to be furnished in a separate sheet of Schedule-C.

54. It is the responsibility of the contractor to procure and store explosive required for blasting operation. Department may render necessary possible help for procuring license.

55. For submission of a tender for the work, the tenderer will be deemed to have satisfied himself by actual inspection of the site and locality of the work about the quality and availability of the required quantity of materials, Medical aid, labour and Flood stuff etc. and that the rates quoted by him in the tender will be adequate to complete the work according to the specifications attached thereto and that he had taken in to account all conditions and difficulties that may be encountered during its progress and to have quoted labour rates and materials with taxes, Octoroi and other duties lead, lifts, loading and unloading freight for materials and all other charges necessary for the completion of the work to the entire satisfaction of the Engineer-in-charge of the work and his authorized subordinates. After acceptance of the contract rates Government will not pay any extra charges for any reason in case the contractor finds later on to have misjudged the conditions as regards the availability of materials, labour and other factors. The contractor will be responsible for any misuse, loss or damages due to any reasons whatsoever of any departmental material during the execution
of work. In case of loss, damage or misuse, recovery at the rate at 5 times the cost of the materials will be deducted from the bills or his other dues.

56. The prevailing percentage of I.T. Department of the gross amount of the bill towards income tax will be deducted from the contractor’s bill.

57. GST at source will be deducted as per the Government rule in force.

58. **Prevailing rate of cess** i.e. @ 1% on estimated cost put to tender as per the Building and Other Constructed Workers (RE&CS) Act. 1996 and Buildings and Other Construction Workers Welfare Cess Act. 1996 (vide resolution No.-12653, dt.15.12.2008 of Labour and Employment Department, Govt. of Odisha) will be deducted from each running bill of the contractor.

59. It must be clearly understood that under no circumstances any interest is chargeable for the dues or additional dues if any payable for the work executed and final bill pending disposal due to any reason whatsoever.

60. No extra payment will be made for removing spreading and consolidating salvaged metals and materials.

61. Under section 12 of contractors labour (Regulation and Abolition) Act. 1970 the contractor who undertakes execution of work through labour should produce valid license from licensing authorities of labour Department.

62. **Performance Security / Additional Performance Security :**

   62.1 If the rate quoted by the bidder is less than 15% of the tendered amount, then such a bid shall be rejected and the tender shall be finalized basing on merits of rest bids. But if more than bid is quoted at 14.99% (Decimals up to two numbers will be taken for all practical purpose) less than the estimated cost, the tender accepting authority will finalize the tender through a transparent lottery system where all bidders / their authorized representatives, the concerned Executive Engineer and DAO will remain present.

   (Amendment to Appendix-IX, Clause-36 of OPWD Code Vol.-II)

   (by inclusion vide O.M.No.12366 dt.08.11.2013).

   62.2 Additional Performance Security shall be obtained from the bidder, when the bid amount is less than the estimated cost put to tender. In such an event, only the successful bidder who has quoted less bid price / rates than the estimated cost put to tender shall have to furnish the exact amount of differential cost i.e. estimated cost put to tender minus the quoted amount as **Additional Performance Security (APS)** in shape of **Term Deposit Receipt** pledged in favour of Divisional Officer / Bank Guarantee in favour of the Divisional officer i.e Executive Engineer, Balsore (R&B) Division No.-II, Balsore from any Nationalized / Scheduled Bank in India counter guaranteed by its local branch at Bhubaneswar within seven days of issue of letter of acceptance (LOA) by the Divisional officer (by e-mail) to the successful bidder, otherwise the bid of the successful bidder shall be cancelled and the earnest money Deposit / Bid security shall be forfeited. Further proceeding for blacklisting shall be initiated against bidder (As amended vide O.M. No.14459 dt.20.09.2018 of Works Deprt Govt of Odisha).

   If the Contractor fails to complete the work, the amount so furnished as additional performance security will be forfeited in addition to the other penal clauses, if any to be imposed.

   (Amendment to Para-3.5.5 (V) Note-II of OPWD Code Vol.-I by substitution of O.M. No.14299 dt.03.10.2017 in place of O.M. No.5288 dt.04.05.2016).

63. **Sample of all material** - The contractor shall supply sample of all materials fully before procurement for the work for testing and acceptance as may be requiring by the concerned Executive Engineer.

64. Super class contractor shall employ under himself two Graduate Engineer and two Diploma holders belonging to the State of Odisha. Special class contractor shall employ under him one graduate Engineer and two Diploma Holders belonging to the state of Odisha. Likewise ‘A’ class contractor shall employ under him one Graduate Engineer or two Diploma Holders belonging to state of Odisha. The contractor shall pay to the Engineering personnel monthly emoluments, which shall not be less than the emoluments of the personnel of equivalent qualification employed under the State Govt. of Odisha. The Engineer-in Chief (Civil), Odisha may however assist the contractor with names
of such unemployed Graduate engineers and Diploma Holders if such help is sought for by the contractor. The names of such Engineering personnel appointed by the Contractors should be intimated to the tender receiving authority along with the tender as to who would be supervising the work. Each bill of the Super Class, Special Class or ‘A’ Class Contractor shall be accompanied by an employment Roll of the Engineering personnel together with a Certificate of the Graduate Engineer or Diploma Holder so employed by the contractor to the effect that the work executed as per the bill has been supervised by him. (Vide Works Department No. Codes M-22/91-15384 dated 9.7.91). The required certificate is to be furnished in the tender documents vide Schedule-G.

65. An engineering personnel of the executing agency should be present at work site at the time of visit of High level Inspecting officers in the rank of Chief Engineer and above.

66. All reinforced cement work should conform to Odisha Detailed specification and should be of proportion as per Contract Agreement having desired compressive strength (in work test) in 15 Cm cubes at 28days, after mixing and test conducted in accordance with IS 456 and IS 516.

67. Bailing out of water from the foundation, pipeline trenches S. Tanks/ Soak pits/ Sumps/ M.H. etc. either rainwater or sub-soil water if necessary should be borne by the contractor. No payment will be made for benchmarks. Level pillars, profiles and benching and leveling the ground wherever required. The rates quoted should be for finished items of works inclusive of these incidental items of work. It should be understood clearly that no claims whatsoever would be entertained.

68. The tenderer shall have to abide by the C.P.W.D. safety code rules introduced by the Government of India, Ministry of work Housing and Supply in their standing order No-44150 dtd.25.11.57.

69. The Contractor will have to submit to the Executive Engineer, Balasore (R&B) Division No.-II, Balasore, monthly return of labour both skilled and unskilled employed by him on the work.

70. All fittings for doors and windows P.H. & Electrical works as supplied by the Contractor should be of best quality and conform to relevant I.S. specification and should be got approved by the Engineer-in-charge of the respective wing before they are used on the work.

71. After completion of the work the contractor shall arrange at his own cost all requisite equipments for testing buildings, if found necessary and bear the entire cost of such test, including the inspection of Electrical Inspectorate.

72. The Tenderer should furnish along with their tender 1. A list of works, which are at present in their hand (Schedule-B) 2. List of T&P (Schedule-C) and 3. List of work executed (Schedule-D) in the prescribed proforma(s) enclosed herewith in appropriate place of bid document.

73. All reinforced cement concrete works should be finished smooth.

74. The tenderer may at his option quote reasonable rate for each item of work carefully so that the rate for one item should not be unworkable low and for others too high.

75. The contractor has to arrange the samples of materials required for execution to be got tested and approved by the Department before taking up the work and during course of execution required from time to time. All such samples will be tested at any of the Departmental Control and Research Laboratories, at the cost of the Contractor with no extra cost to the Department.

76. If there is any damage to the work due to natural calamities like flood or cyclone or any other cause during the course of execution of work or up to 6 months after completion of work or if any, imperfection becomes apparent to the work within 6 months from the date of final certificate of completion of work the contractor shall make good of all such damages at his own cost with no extra cost to the Department. No claims, whatsoever, in this regard will be entertained.

77. The Fly Ash Bricks should be of good qualities. The bricks should be approved by the Engineer-in-Charge before use in the work and should confirm to the minimum strength and other criteria as per National Building Code.

78. Under Section 1 of contract labour Regulation and Abolition Act 1970 the contractor who undertakes execution of work through labour should produce valid license from the licensing authority of labour Department.
79. Standard co-efficient for linear measurement will be adopted while calculating consumption of steel and no claim whatsoever regarding difference in co-efficient of steel will be entertained. The rates quoted shall be inclusive of any eventuality of difference for co-efficient for linear measurements.

80. Engineer Contractor desirous to avail the facility of exemption of E.M.D is required to submit an affidavit to the effect that he has not yet availed the facility / participated in the tender for more than two works (Excluding this work) during the current financial year. The name of work for which participated and the authority to whom the tender was submitted must be mentioned in the affidavit, failing which the tender will be rejected.

81. That for the purpose of jurisdiction in the event of disputes if any of the contract would be deemed to have been entered in to within the State of Odisha and it is agreed that neither party to the contract will be competent to bring a suit in regard to the matter by this contract at any place outside the State of Odisha.

82. SPECIAL CONDITIONS (PART OF THE CONTRACT)

(I) All materials before they are being used in the items of works as per this Schedule of quantities and also the finished items of work where tests are applicable shall have to be tested through the Engineer-in-charge of the respective wing at appropriate Laboratories according to the relevant I.S. specifications of the materials and the said items of works and the cost of all such tests shall have to be borne by the Contractor and the rates of the items of works should be inclusive of cost of such tests.

(II) The tests have to be planned & carried out such that the progress of work is not hampered

(III) The tests are mandatory as per the prescribed frequencies and I.S. specifications. However, these are not exhaustive and the Engineer-in-charge has the right to prescribe other required test if any as will be considered from time to time.

83. In case of ambiguity between clauses of this D.T.C. N. and the P-1 contract form, the relevant Clauses of the P-1 contract form shall prevail over the D.T.C.N. The clauses not covered under P-1 contract form shall be governed by the clauses of the D.T.C.N.

84. It must be definitely understood that the Government does not accept any responsibility for the correctness and completeness of the trial borings shown in the Cross Section.

85. Schedule of quantities is accompanied in Cover-II (Price Bid). It shall be definitely understood that the Government does not accept any responsibility for the correctness or completeness of this schedule and that this schedule is liable for alteration or omissions, deductions or alternations set forth in the conditions of the contract and such omissions, deductions, additions or alternations shall no way invalidate the contract and no extra monetary compensation, will be entertained.

86. In case of any complaint by the labour working about the non-payment or less payment of his wages as per latest minimum Wages Act, the Executive Engineer will have the right to investigate and if the contractor is found to be in default, he may recover such amount due from the contractor and pay such amount to the labour directly under intimation to the local labour office of the Govt. The contractor shall not employ child labour. The decision of the Executive Engineer is final and binding on the contractor.

87. The contractor should arrange the materials like Steel, Cement, paint and bitumen etc. of approved quality and specification at his own cost for completion of the work with the time schedule. No extension of time will be granted on the application of the contractor due to delay in procurement of materials.

88. The bidder will be responsible for the loss or damage of any departmental materials during transit and in the execution of the work due to reasons what-so-ever and the cost of such materials will be recovered from the bills at stock issue rates or market rates whichever is higher.

89. If the contractor removes Government materials supplied to him from the site of work with a view to dispose of the same dishonesty, he shall be in addition to any other liability civil or criminal arising out of his contract be liable to pay a penalty equivalent to five times of the price of the materials according to the stock issue rate or market rate whichever is higher. The penalty so imposed shall be
recovered at any time from any sum that may then or at any time thereafter become due to the contractor or from his security deposit or from the proceeds of sale thereof.

90. The selected contractor may take delivery of departmental supply according to his need for the work issued by the **Sub-Divisional Officer in-charge** subject to the availability of the materials. The tenderer shall make all arrangement for proper storages of materials but no cost for raising shed for storage, pay of security guard etc. will be borne by the Department. The Department is not responsible for considering the theft of materials at site. It is the contractor’s risk. Under any such plea if the tenderer stops the work, he shall have to pay the full penalty as per clause of **F2 agreement**.

91. The Department will have the right to supply at any time in the interest of work any departmental materials to be used in the work and the contractor shall use such materials without any controversy or dispute on that account. The rate of issue of such materials will be at the stock issue rates inclusive of storage charges or rates fixed by the Department or current market rate whichever is higher.

92. All the materials which are to be supplied from P.W.D. store will be as per availability of stock and the contractor will have to bear the charges of straightening, cutting, jointing, welding etc. to required sizes in case of M.S. Rods or TOR Steel / M.S Angles, Tees and Joists etc. After the issue from the P.W.D. store, the materials may be under the custody of the contractor and the contractor will be responsible for its safety and storage. Cut pieces of steel more than one meter in length will be returned by the contractor at the issuing stores without conveyance charges.

93. Though Departmental issue of cement and steel has indicated, it may not be taken as binding. The contractor must have to arrange by themselves cement, steel, bitumen and every sort of materials from approved manufacturer, get it tested in the Departmental Laboratory and approved by the Department before use. No extension of time or escalation of price on such account shall be entertained in future.

94. TOR rods, plates and structural members will be supplied in quantity, length and size available in the stock. For payment of reinforcement, the steel including plates etc. shall be measured in length of different diameter, size and specification as actually used (including hooks and cranks) in the work correct to an inch or cm. And their weight calculated as per sectional weight prescribed by the Indian Standard Specification or as directed by the Engineer-in-Charge (Wastage of bars and unnecessary lapping will not be considered for measurement and payment).

95. Odisha Bridge & Construction Corporation Ltd. will be allowed price preference up to 3% over the lowest quotation or tender as laid down in Works and Transport Department Resolution No-285 date-17.04.1974. The **Odisha Construction Corporation** will be allowed a price preference to the extent of up to 3% over the lowest tender amount (Where their tender is not the lowest) provided they express willingness to execute the work after reduction of rates by negotiation.

96. The contractor is required to pay royalty to Govt. as fixed from time of time and produce such documents in support of their payment to the concerned Executive Engineer with their bills, falling which the amount towards royalties of different materials as utilised by them in the work will be recovered from their bills and deposited in the revenue of concerned department.

97. **Trial Boring** - The foundation level as indicated in the body of the departmental drawing is purely tentative and for the general guidance only. The Department has no responsibility for the suitability of actual strata at the foundation level. The contractor has to conduct his own boring before starting the work and get the samples tested at his own cost to ascertain the S.B.C. and credibility of the strata at founding level while quoting his rates for tender the contractor shall take in to account of the above aspects.

98. Any defects, shrinkage or other faults which may be noticed within 12 (Twelve) months from the completion of the work arising out of defective or improper materials or workmanship timing are upon the direction of the Engineer-in-Charge to be amended and made good by the contractor at his own cost unless the Engineer for reasons to be recorded in writing shall be decided that they ought to be paid for and in case of default Department may recover from the contractor the cost of making good the works. The contractor is also required to maintain the road/ building for 12 (Twelve) months from the date of successful completion of the work.
99. From the commencement of the works to the completion of the same, they are to be under the contractors charge. The contractor is to be held responsible to make good all injuries, damages and repairs occasioned or rendered necessary to the same by fire or other causes and they hold the Govt. of Odisha harmless for any claims for injuries to person or structural damage to property happening from any neglect, default, want of proper care or misconduct on the part of the contractor or any one in his employment during the execution of the work. Also no claim shall be entertained for loss due to earthquake, flood, cyclone, epidemic, riot or any other calamity whether natural or incidental damages so caused will have to be made good by the contractor at his own cost.

100. **Gradation of ingredients**: The coarse and fine aggregate shall meet the grade requirement as per the latest provision of relevant. I.S. Code / I.R.C. code / MoRT&H specifications.

101. Where it will be found necessary by the Department, the Officer-in-Charge of the work shall issue an order book to the contractor to be kept at the site of the work with pages serially numbered. Orders regarding the work whenever necessary are to be entered in this book by the P.W.D. Officer-in-Charge with their dated signatures and duly noted by the contractor or his authorized agents with their dated signature. Orders entered in this book and noted by the contractor’s agent shall be considered to have been duly given to the contractor for following the instructions of the Department. The order Book shall be the property of the P.W.D. and shall not be removed from the site of work without written permission of the Engineer (Executive Engineer) and to be submitted to the Engineer-in-charge every month.

102. The contractor should attach the certificate in token of payment deposit with the registration authority as per recent circular of the Government relating to his registration.

103. In case of any discrepancy in printing or omissions of statutory specifications or any other part or portion of the approved document during download of the bid document, the decision of the officer inviting the bid will be binding on the bidder.

104. The rates quoted by the contractor shall cover the latest approved rates of Labours, Materials, P.O.L. and Royalties. Arrangement of borrow areas i.e. Land, Approach Road to the building site etc. are the responsibility of the contractor.

105. The rate for each work of concrete items wherever dewatering is imperatively necessary the term dewatering shall mean the execution or operation of the items due to standing water as well as due to percolation of water. The quoted rates will be inclusive of this.

106. The contractor shall make requisition of claim book from the date of commencement of the work from the Department and shall maintain in proper P.W.D. form with pages serially numbered in order to record items of works are not covered by his contract and claimable as extra. Claims shall be entered regularly in this book under the dated signature of the contractor or his duly authorized agents at the end of each month. A certificate should be furnished along with the claim to the effect that he has no other claim beyond this claim up-to-date. If in any month there are no claims to record, a certificate to that effect should be furnished by the contractor in the claim book. Each claim must be defined and should be given as far as possible regarding the quantities as well as the total amount claimed. The claim book must be submitted by the contractor regularly by 10th and 16th days of each month for orders of the Engineer-in-Charge or competent authority. Claims not made in this manner or the claim book not maintained from the commencement of the work is liable to be summarily rejected. The claim book is the property of the P.W.D. and shall be surrendered by the contractor to the Engineer-in-charge after completion of the work or before recession of the contract by the Department whichever is earlier for record.

107. Number of tests as specified in I.R.C. / MoRT&H / I.S.I specification required for the construction of roads / bridges / buildings or any other structural works will be conducted in any Govt. Test House /Departmental laboratories/reputed material testing laboratory as to be decided by the Engineer-in-charge. Testing charges including expenditure for collection / transportation of samples /specimens etc. will be borne by the contractor. The collection of samples and testing are to be conducted for both prior to execution and during execution as may be directed by the Engineer-in-charge and on both the accounts the cost shall be borne by the contractor.

108. Even qualified criteria are met, the bidders can be disqualified for the following reasons, if enquired by the Department
(a) Making a false statement or declaration.
(b) Past record of poor performance.
(c) Past record of abandoning the work half way/ recession of contract.
(d) Past record of in-ordinate delay in completion of the work.
(e) Past history of litigation.

109. In case the 1st lowest tenderer or even the next lowest tenderers withdraw in series one by one, thereby facilitating a particular tender for award, then they shall be penalized with adequate disincentives with forfeiture of EMD unless adequate justification for such back out is furnished. Appropriate action for black listing the tenderers shall also be taken apart from disincentives against the tenderer.

110. The following documents which are not submitted with the Bid, will be deemed to be part of the Bid:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Notice Inviting tender</td>
</tr>
<tr>
<td>2</td>
<td>Instruction to the Bidders</td>
</tr>
<tr>
<td>3</td>
<td>Conditions of Contract.</td>
</tr>
<tr>
<td>4</td>
<td>Contract data</td>
</tr>
<tr>
<td>5</td>
<td>Specifications</td>
</tr>
<tr>
<td>6</td>
<td>Drawings</td>
</tr>
</tbody>
</table>

111. **Condition for issue of plant & machinery to contractor on hire:** - Tools & plants will be issued to the contractor only if it is desirable in the interest of Govt. works and if these can be spared without inconvenience to the Department. The Sanction of the Chief Engineer shall be necessary in each case. The contractor shall arrange his programme of work according to the availability of the plant & machinery & no claim will be entertained for any delay in supply by the Department.

An agreement shall be entered in to by the contractor to the effect that these hire charges are recoverable from the bills of the contractor regularly and the final payment for the work including refund of security deposit will not be made until the total amount due to the Government on account of hire of machinery etc. is recoverable in full. Full amount of hire charges due from the contractor at any contract at any time shall be recovered from his next subsequent bill. All transit and incidental charges in connection with the despatch of tools and plants and machineries from workshop shed/ deposit return there to, will be borne by the contractor. The hire charge shall be recovered at the prescribed rates from and inclusive of the date, the plant and machinery is made over up to and inclusive of the date of its return, even though the same day it may not have been utilised for any reason except for a major break down which may take more than 72 hours for repairs. The contractor shall immediately intimate in writing to the Engineer–in-charge when any plant or machinery goes out of order requiring major repairs. The hire charges are for clock hours. In case of tar boilers, hot mix plant and any other machinery requiring similar preparation the working hour will include the time required to make up the boiler temperature and bring plant to the operating conditions before the actual start of work. The machine will work in shifts of 8 hours each. Extra charges towards overtime wages of any of the operating and maintenance staff will be leviable. These charges will be fixed by the Engineer-in-charge from time of time. In no case, the tools and plants shall be operated beyond 8 hours in any shift without prior written permission of the Engineer-in-charge.

The contractor shall release the plant and machinery as and when required for periodical servicing and maintenance. He shall also provide for any labour and water source for washing the plants. In the case of Concrete mixtures, pavers and similar such type of equipments, the contractor shall arrange to get the hopper cleaned and the drums etc. washed at the close of work each day. The plant and machinery once issued to a contractor shall not be returned by him on account of lack of arrangement of labour and material etc. on his part. The same will be returned only when they do not
require or when in the option of Engineer-in-charge the work or a portion of work for which issued is completed.

The tools and plants shall while in transit and in the custody of contractor be at his sole risk and responsibility for damages and / or loss except fair wear and tear. The damage or loss as assessed by Engineer-in-charge shall be made good by the contractor. In the event of a disagreement as to the extent of damage or the value of article lost, the decision of Chief Engineer shall be final. The contractor shall on or before the supply of plant and machinery sign an agreement in indemnifying the Govt. against loss or damage to the machine. The Contractor shall also be responsible for any claim for compensation for loss of life, injury or damages to property etc. arising from any cause what-so-ever. The contractor shall provide full time choukidar for guarding the plant and machinery at site.

If the articles are not returned within the date originally specified or extended by the Engineer in Charge, in addition to the normal hire charge, a surcharge equal to 10% of the hire charges will be levied for the period that the machinery is not returned. Such period will be treated as working time. In the event of the non-return of the machinery, the full value of the articles at the current market price will be recovered from the contractor's outstanding bills or any bills that may become due in respect of his other work under the state public works Department. The decision of the Chief Engineer shall be final in case of dispute.

**FORM OF AGREEMENT** – The contractor shall, before taking the possession of the machinery, enter into an agreement with the Engineer-in-charge or his nominees in the form attached. Log Books for recording the hours of daily works for each of the plant and machinery supplied to the contractor will be maintained by the Department will be attested by the contractor or his authorized agent daily. In case of contractor contests the correctness of the entries and / or fails to sign the logbook, the decision of the Engineer-in-charge shall be final and binding on him. Hire charges will be calculated according to the entries in the logbook and will be binding on the contractor.

**AGREEMENT FOR LOANS OF GOVERNMENT TOOLS & PLANTS**

This agreement made on the ……………………………………………… Two Thousand between (herein-after referred to as “the hirer” which expression shall unless excluded by or repugnant to the context include his heirs, executors, administrators and assigns) of the one part and the Govt. of Odisha (here in after referred to as the Governor which expression shall unless excluded by or repugnant to the context include his successors in office as assigns) of the other part. Whereas the hirer desirous of hiring the tools and plants of the P.W. Department of the Odisha Govt. and more particularly specified in the schedule here under referred to as “the tools and plants”. And whereas Government has agreed to let in hire the tools and plants to the hirer on the terms and conditions here in after mentioned. Now it is here by and between the parties here to as follows :-

a) In consideration of agreement that hire charges be recovered from their bill for work executed on which this machinery will be used or any other than standing in the names of contractors in the book of the Department or any other Government Department. The Govt. agrees to let the hirer tools and plants for the period to be computed from the date of delivery of the tools and plant to the hirer at the P.W. Department workshop / store at Balasore.

b) The rate of higher charges will be as mentioned in the schedule attached.

c) The hirer shall not transfer, assign or sublet or in any way part with the tools and plants or any part there-of without the previous written approval of the Engineer-in-charge

d) On the expiry of the period of the hire, the hirer shall return the tools and plants to the Public Works Department. & Workshop / store at Balasore in the same good condition in which they were received by him.

e) In the event of the tools and plants not being returned on the expiry of the above-mentioned period, the hirer shall without prejudice and any other liability pay to the Government on account equivalent to the rate of hire specified for the working period and an increase of ten percent.

f) The tools and plants shall be open for inspection at all times to the officers of the Government.
g) The hirer shall not operate the tools and plants so hired for more than one shift / two shifts of 8 hours each per day without the prior sanction of the Engineer-in-charge. If the hirer operates the tools and plants beyond the aforesaid limit without the prior sanction of the Assistant Engineer, he shall pay to Government additional hire charges as well as over time charges for staff for such excess operation at the rate approved by the Engineer-in-charge from time to time.

h) In case of breakdown, repairable at the site within a period of three days hire charges as specified in the schedule will be levied except in case of major repairs.

i) Normally the tools and plants will be supplied with operating staff.

j) The hirer shall be responsible for any claims for compensation for loss of life, injury or damage to property etc. arising due to any causes what-so-ever during the period of the machinery is in his charge.

k) All municipal or other dues and taxes payable on account of the use or operation of the tools and plants for the period of hire shall be defrayed by the hirer.

l) The hirer shall make good any loss or damages arising out of causes other than fair wear and tear to the tools and plants during the period of hire. The cost recoverable from the hirer shall be the full replacement value as determined by the Engineer-in-charge. In the event of any loss or damage not being made good by the hirer to the satisfaction of the said Engineer-in-charge the office shall be at liberty to make good himself such loss or damage and recover the cost thereof from the hirer. The hirer shall pay to the Engineer-in-charge such an amount as shall be necessary to make good the loss or damage failing which the same will be recovered from his dues as in case of hire charges.

m) On the breach of any terms or conditions of this agreement by the hirer the Engineer-in-charge shall be entitled to demand the return of tools and plants and the hirer shall return the tools and plants within 72 hours from the date of receipt of such order in writing. In case of failure on the part of the hirer to comply with such order he shall be liable to pay such penalty as may be imposed by the Engineer-in-charge for the period the tools and plant are detained provided that the maximum penalty shall not exceed the cost replacement of the tools and plants.

n) In case of any disputes between the hirer and the Government, the decision of the Chief Engineer shall be final.

o) This agreement shall be operated by the Engineer-in-charge on behalf of the Government and the term Engineer-in-charge shall include all officers duly authorised by him to exercise powers on his behalf.

THE SCHEDULE

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Description and Name of the articles</th>
<th>No.</th>
<th>Amount of hire per hour</th>
<th>Remarks</th>
</tr>
</thead>
</table>

In witness whereof the hirer and the Engineer-in-Charge has for and on behalf of the Governor of the State has set their respective hand, the day and the year here in above written.

Signed by:

1. 
2. 

Signed sealed and delivered in the presence of
112. **ELIGIBILITY CRITERIA:**

To be eligible for qualification, applicants shall furnish the followings. Non-furnishing of the following particulars shall be treated as ineligible.

a. **Required E.M.D (Bid Security) as per the Clause No.20 of DTCN**

b. **Cost of bid document towards Cost of tender paper as per Clause No.4 of DTCN.**

c. **Scanned copy of valid Contractor Registration Certificate, GST Registration Certificate, GSTIN, PAN card along with the tender documents and the L-I bidder has to furnish the Original Registration certificate, GSTIN and Pan card for verification within (5) Five days of opening of Cover-II of the tender before Chief Engineer, (Buildings), Odisha, Bhubaneswar as per Clause No-1, 5(i) and 21 of DTCN. The contractor belonging to outside state of Odisha and not started business should submit an undertaking in the form of an Affidavit indicating therein that they are not registered under Odisha GST as they have not started any business in the state and they have no liability under the Act. But before award of final contract, such bidders will have to produce the GST Registration certificate.**

d. **i) License criteria as per Clause No.8 of DTCN and Schedule-J need to be furnished.**

ii.) **Prequalification criteria for Fire Protection services & Scope of services such as Design, Supply, installation, testing, commissioning for fire protection works are given below.**

1. Bidders shall make MOU with a professional firm or body who has competence and experience in installation of fire safety services of high rise buildings.
2. The said firm must have registered under any state Govt. / Central Govt. Organization for installation & commissioning of Fire Safety services, the certificate in support of these are to be furnished.
3. The firm must have executed at least one similar work costing not less than Rs.123.00 Lakhs / 2 or 3 work not less than Rs.41.00 lakhs aggregating to Rs.123.00 lakhs during Current / last five Financial years under Govt. / Semi Govt./ Reputed Private Sectors in support of which , certificate to this effect should be furnished from an officer not below the rank of E.E or equivalent.

**C.)Prequalification criteria for Air Conditioning System & Scope of services such as Design, Supply, installation, testing, commissioning for HVAC work given below.**

1. Bidders shall make MOU with a professional firm or body who has competence and experience in installation of HVAC (Chiller System) of high rise buildings.
2. The said firm must have registered under any state Govt. / Central Govt. Organization for installation & commissioning of HVAC (Air Conditioning), the certificate in support of these are to be furnished.
3. The firm must have executed at least one similar work costing not less than Rs.423.00 Lakhs / 2 or 3 work not less than Rs.141 lakhs aggregating to Rs 423.00 lakhs during Current / last five Financial years under Govt. / Semi Govt./ Reputed Private Sectors in support of which , certificate to this effect should be furnished from an officer not below the rank of E.E or equivalent.

e. **Evidence of ownerships of machineries/ equipments as per Clause No.7 of DTCN and need to be furnished by the bidder in Schedule-C.**

f. **Joint Ventures are not accepted.**

g. The bidder should have satisfactorily executed two / three similar works in Govt., or Govt undertaking organization each costing ₹.1976.00 Lakh or more aggregating to ₹.5928.00 Lakh or more or executed one similar work costing ₹.5928.00 Lakh or more in any one Financial year during Current / last five years. Experience detailing completed similar nature of works during Current / last five years, with Certificates from the concerned Officer not below the rank of Executive Engineer or Equivalent need to be furnished by the bidder as per Schedule D. (Similar nature of works means construction of buildings inclusive of Electrical installations and P.H. works.)

h. **BID CAPACITY - (Vide Works Department Office Memorandum No.6300 dtd.16.6.2011)**

Applicants who meet the minimum qualification criteria will be qualified only if their available bid capacity at the expected time of bidding is more than the total estimated cost of the works. The available bid capacity will be calculated as under.
Assessed Available Bid Capacity = (A*N*2-B), where
A = Maximum value of works executed in any one year during the last five years (updated to the current price level) rate of inflation may be taken as 10% per year (escalation factor) which will taken into account the completed as well as works in progress.
B = Value of current price level of the existing commitments and ongoing works to be completed during the next years (period of completion of works for which Bids are invited).
N = Number of years prescribed for completion of the work for which the Bids are invited.

(for work completion period less than one year the value may be taken as one year)

Note : In case of a Joint Venture the available Bid capacity will be applied for each partner to the extent of his proposed participation in the execution of the works.
The Statement showing the value of existing commitments and ongoing works as well as the stipulated period of completion remaining for each of the works listed should be countersigned by the Engineer-in-Charge not below the rank of an Executive Engineer.

**Escalation Factor :** Following enhancement factors will be used for the cost of works executed and the financial figures to a common base value for works completed in India.

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(Applicant should indicate actual figures of costs and amounts for the works executed by them without accounting for the above mentioned factors)

In case the financial figures and value of completed works are in foreign currency the above enhanced multiplying factors will be applied. Instead, current market exchange rate(State Bank of India BC selling rate as on the last date of submission of the bid) will be applied for the purpose of conversion of amount in foreign currency into Indian rupees.

The information on Bid Capacity as on the date of this bid is to be furnished as per the format in Schedule-B.

Total value of Civil Engineering construction work performed in the last five years are to be furnished for which certificate from Chartered Accountant is to be furnished.

<table>
<thead>
<tr>
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<tr>
<td>2015-2016</td>
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I. Non submission of required information in schedule B, D, E and F shall be treated as non-responsive and the bid shall be summarily rejected.

113. **Time Control :** (Vide Works Department Office Memorandum No.24716 dtd.24.12.2005 and No.8310 dtd.17.05.2006)

a) Progress of work and Re-scheduling programme.
i) The Executive Engineer / Engineer-in-Charge shall issue the letter of acceptance to the successful contractor. The issue of the letter of acceptance shall be treated as closure of the Bid process and commencement of the contract.

ii) Within 15 days of issue of the letter of acceptance, the contractor shall submit to the Engineer-in-Charge for approval a Programme showing the general methods, arrangements, and timing for all the activities in the Works along with monthly cash flow forecast.

iii) To ensure good progress during the execution of the work the contractors shall be bound in all cases in which the time allowed for any work exceeds one month to complete, 1/4th of the whole time allowed under the contract has elapsed, ½ of the whole of the work before ½ of the whole time allowed under the contract has elapsed, 3/4th of the whole of the work before 3/4th of the whole time allowed under the contract has elapsed.

iv) If at any time it should appear to the Engineer-in-Charge that the actual process of the work does not conform to the programme to which consent has been given the Contractor shall produce, at the request of the Engineer-in-Charge, a revised programme showing the modifications to such programme necessary to ensure completion of the works within the time for completion. If the contractor does not submit an updated Programme within this period, the Engineer-in-Charge may withhold the amount of 1% of the contract value from the next
payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Programme has been submitted.

v) An update of the Programme shall be a programme showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.

vi) The Engineer-in-Charge’s approval of the Programme shall not alter the Contractor’s obligations. The Contractor may revise the Programme and submit it to the Engineer-in-Charge again at any time. A revised Programme is to show the effect of Variations and Compensation Events.

b) Extension of the Completion Date.

i) The time allowed for execution of the works as specified in the Contract data shall be the essence of the Contract. The execution of the works shall commence from the 15th day or such time period as mentioned in letter of Award after the date on which the Engineer-in-Charge issues written orders to commence the work or from the date of handing over of the site whichever is later. If the Contractor commits default in commencing the execution of the work as aforesaid, Government shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the earnest money & performance guarantee / Security deposit absolutely.

ii) The Contractor shall submit the Time & Progress Chart for each milestone Quarter wise indicating each month and get it approved by the Department. The Chart shall be prepared in direct relation to the time stated in the Contract documents for completion of items of the works. It shall indicate the forecast of the dates of commencement and completion of various trades of sections of the work and may be amended as necessary by agreement between the Engineer-in-Charge and the Contractor within the limitations of time imposed in the contract documents, and further to ensure good progress during the execution of the work, the contractor shall in all cases in which the time allowed for any work, exceeds one month (save for special jobs for which a separate programme has been agreed upon) complete the work as per milestone given in contract data.

iii) In case of delay occurred due to any of the reasons mentioned below, the Contractor shall immediately give notice thereof in writing to the Engineer-in-Charge but shall nevertheless use constantly his best endeavors to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-in-Charge to proceed with the works.

   (1) Force majeure, or
   (2) Abnormally bad weather, or
   (3) Serious loss or damage by fire, or
   (4) Civil commotion, local commotion of workmen, strike or lockout affecting any of the trades employed on the work, or.
   (5) Delay on the part of other contractors or tradesmen engaged by Engineer-in-Charge in executing work not forming part of the Contract.
   (6) In case a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date without the Contractor taking steps to accelerate the remaining work and which would cause the Contractor to incur additional cost, or
   (7) Any other cause, which, in the absolute discretion of the authority mentioned, in Contract data is beyond the Contractors control.

iv) Request for reschedule and extension of time, to be eligible for consideration, shall be made by the Contractor in writing within fourteen (14) days of the happening of the event causing delay. The Contractor may also, if practicable, indicate in such a request the period for which extension is desired.

v) In any such case a fair and reasonable extension of time for completion of work may be given. Such extension shall be communicated to the Contractor by the Engineer-in-Charge in writing, within 3 months of the date of receipt of such request. Non-application by the contractor for extension of time shall not be a bar for giving a fair and reasonable extension by the Engineer-in-Charge and this shall be binding on the contractor.

c) Compensation for Delay.

If the contractor fails to maintain the required progress in terms of clause-2 of P-1 Contract or to complete the work and clear the site on or before the contract or extended date of completion, he shall, without prejudice to any other right or remedy available under the law to the Government on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below as the Superintending Engineer (whose decision in writing shall be final and binding) may decide on the amount of tendered value of the work for every completed day / month (as applicable) that the progress remains below that
specified in Clause-2 of P-1 Contract or that the work remains incomplete. This will also apply to items or group of items for which a separate period of completion has been specified. Compensation @ 1.5% per month of for delay of work, delay to be completed on per Day basis. Provided always that the total amount of compensation for delay to be paid under this condition shall not exceed 10% of the Tendered Value of work or to the Tendered Value of the item or group of items of work for which a separate period of completion is originally given. The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this or any other contract with the Government. In case, the contractor does not achieve a particular milestone mentioned in contract data, or the rescheduled milestone(s) in terms of Clause-2.5, the amount shown against that milestone shall be withheld, to be adjusted against the compensation levied at the final grant of extension of time. Withholding of this amount on failure to achieve a milestone shall be automatic without any notice to the contractor. However, if the contractor catches up with the progress of work on the subsequent milestone(s), the withheld amount shall be released. In case the contractor fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be withheld. However no interest whatsoever shall be payable on such withheld amount.

d) Bonus for early completion

For availing incentive clause in any project which is completed before the stipulated date of completion, subject to other stipulations it is mandatory on the part of the concerned Executive Engineer to report the actual date of completion of the project as soon as possible through fax or e-mail so that the report is received within 7 days of such completion by the concerned Superintending Engineer, Chief Engineer & the Administrative Department. The incentive for timely, completion should be on a graduated scale of one percent to 05 percent of the contract value. Assessment of incentives may be worked out for earlier completion of work in all respect in the following scale:

- Before 30% of contract period = 5% of Contract Value
- Before 20 to 30% of contract period = 4% of Contract Value
- Before 10 to 20% of contract period = 3% of Contract Value
- Before 5 to 10% of contract period = 2% of Contract Value
- Before 5% of contract period = 1% of Contract Value

(Amendment to Para-3.5.5 (V) of Note-III of OPWD Code Vol.-I by inclusion vide O.M. No.5288 dt.04.05.2016)

e) Management Meetings

- Either the Engineer or the Contractor may require the other to attend a management meeting. The business of management meetings shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.
- The Engineer shall record the business of management meetings and is to provide copies of his record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken to be decided by the Engineer either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

Rescission of Contract (Amendment as per letter No.10639 dt.27.05.2005 of Works Department, Odisha):- To rescind the contract (of which rescission notice in writing to the contractor under the hand of the Executive Engineer shall be conclusive evidence), 20% of the value of left over work will be realized from the contractor as penalty.

114. Building and other Construction Workers Welfare Cess @ 1% of the estimated cost as per tender notification read with latest corrigendum if any will be proportionately deducted from the contractor's bill at the time of making payment of each bill.

115. The tenderers are required to go through each clause of P.W.D. Form P-1 carefully in addition to the clauses mentioned here in before tendering.

116. A Contractor may be black listed as per amendment made to Appendix XXXIV to OPWD Code Vol.-II on rules for black listing of Contractors vide letter no.3365 dt.01.03.2007 of Works Department, Odisha.

As per said amendment a Contractor may be blacklisted

- Misbehavior/threatening of Departmental & supervisory officers during execution of work/tendering process.
- Involvement in any sort of tender fixing.
c) Constant non-achievement of milestones on insufficient and imaginary grounds and non-
    adherence to quality specifications despite being pointed out.

d) Persistent and intentional violation of important conditions of contract.

e) Security consideration of the State i.e. any action that jeopardizes the security of the State.

f) Submission of false/ fabricated / forged documents for consideration of a tender.

117. The safety certificate of the E.I. work will be furnished by the agencies after getting necessary
    verification from the electrical inspector / equally competent authority responsible for the work prior
    to Energisation of the building.

118. Percentage rate contract (vide Works Department letter no.8310 dt.17.05.2006) In case of
    percentage rate tender:-

ii) The Contractor has to mention percentage excess or less over the estimated cost (In figures as
    well as words) in the prescribed format appended to the tender document.

iii) Contractors participated in the tender for more than one work may offer conditional rebate.
    Rebate offer submitted in separate sealed envelope shall be opened, declared and recorded
    first. The rebate so offered shall be considered after opening of all packages called in the same
    Tender Notice. The Contractors who wish to tender for two or more works shall submit separate
    tender for each. Each tender shall have the Bid Identification No., Name & Sl. No. of the work
    (as per IFB) to which they refer, written on the envelope.

iv) Only percentage quoted shall be considered. Percentage quoted by the Contractor should be
    accurately filled-in figures and words, so that there is no discrepancy.

(1) If any discrepancy is found in the percentage quoted in words and figures, then the
    percentage quoted by the Contractor in words shall be taken as correct

(2) If any discrepancy is found in the percentage quoted in percentage excess/ less and the
    total amount quoted by the Contractor, then percentage will be taken as correct.

(3) The percentage quoted in the tender without mentioning excess or less and not
    supported with the corresponding amount will be treated as excess.

(4) The percentage quoted in the tender without mentioning excess / less supported with
    corresponding amount does not tally with either to percentage excess or less then it will
    be treated as percentage excess.

(5) The percentage quoted in the tender without mentioning excess / less supported with
    corresponding amount if tallied with the percentage then it will be treated as to which side
    the amount tallies.

(6) The Contractor will write percentage excess/ less up to two decimal point only.

(7) The tender shall be written legibly and free from erasures, over writings or corrections of
    figures. Corrections, over writings & interpolations where unavoidable should be made by
    making out, initialing, dating and rewriting.

v) In the contract P1 time is the essence. The contractor is required to maintain a certain rate of
    progress specify in the contract.

vi) The quantity mentioned can be increased or reduced to the extent of 10% for individual items
    subject to a maximum of 5% over the estimated cost. If it exceeds the limit stated above prior
    approval of competent authority is mandatory before making any payment.

vii) The period of completion is fixed and cannot be altered except in case of exceptional
    circumstances with due approval of next higher authority.

viii) Bills for percentage rate tenders shall be prepared at the estimated rates for individual items only
    and the percentage excess or less shall be added or subtracted from the gross amount of the
    bill.

(Total 118 Clauses)

APPROVED

Sd/-
Chief Engineer, (Buildings),
Odisha, Bhubaneswar
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LISTOFAPPROVEDMAKES

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1. FOAM CONCRETE

Foamed concrete / cellular light weight concrete is produced by the mixing of Portland cement, sand including or alone fly ash, water and preformed stable foam. The foam is produced with the help of a foam generator by using foaming agent. The air content should be between 40 to 80 percent of the total volume. The bubbles vary in size from around 0.1 to 1.5 mm in diameter.

Foamed concrete shall be produce by mixing the below mentioned ingredients in ready mix plant or ordinary concrete mixer. Foamed concrete is self-compacting concrete requires no compaction. It can be pumped successfully over significant height and distances.

The plastic density of the material is about 150 kg/m3 higher than its dry density.

BATCHING AND MIXING:

The dry ingredients cement, sand, sand + fly ash or fly ash alone shall be fed into the mixer first and thoroughly mixed to ensure even distribution of cement. The appropriate amount of water shall be added thereafter continuing the mixing. The preformed foam, which is made by blending the foam concentrate, water and compressed air in predetermined proportion in a foam generator, calibrated for a specific discharge rate, shall be added in measured amount (to the slurry of cement, sand, fly ash and water in the batch mixer.

For cast-in-situ foamed concrete, the preformed foam shall be added at the job site just prior to pumping or otherwise conveying the concrete into forms.

Curing shall be done as per IS: 456-2000.

<table>
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<th>Required density (kg/m³)</th>
<th>Required Compressive Strength at 28-day (N/mm²)</th>
<th>W/C +FA ratio</th>
<th>O PC 53 gr</th>
<th>Sand (kg)</th>
<th>Water (Kg)</th>
<th>Quantity of Foaming Agent (Kg)</th>
</tr>
</thead>
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<tr>
<td>500</td>
<td>2.0</td>
<td>0.54</td>
<td>310</td>
<td>210</td>
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<td>1.4</td>
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2. WATER PROOFING TREATMENT (PRE-CONSTRUCTION) BY CHEMICAL INJECTION SYSTEM

A. HORIZONTAL SURFACE (RAFT SLAB)

i. Before the raft reinforcement is placed in position:
   a. Laying PCC as per drawings and specifications.(payable under the corresponding item)
b. Cement slurry (cement and approved water proofing compound) is spread on the PCC for proper bonding with subsequent water proofing treatment.

c. Water Proofing Course of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound is laid over the slurry. Stone aggregates 12mm down is embedded at random.

d. After 24 hours, spreading cement slurry (cement and approved water proofing compound) on the 1st layer of mortar.

e. Providing and laying 2nd layer of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound. Stone aggregate 12mm down size is embedded at random.

ii. After reinforcement of raft is placed in position:

a. Providing and fixing 25mm dia GI threaded grouting nozzles of adequate length at the specified locations @ 1.50 metres c/c or as shown in the drawing all over the slab. The grouting nozzles are tied with reinforcement in such a manner as not to choke its end during concrete operations. The top of these nozzles protrudes above the raft concrete.

b. After minimum 7 days of concreting, cement grout of cement and approved water proofing compound (non-shrinkage grouting compound) in proportion as specified is injected, through these nozzles at the pressure of 2.5 to 3.0 Kg/Sq.cm.

c. After grouting, top of the nozzles is cut and the space is filled with cement mortar 1:2 (1 cement: 2 coarse sand) mixed with approved water proofing compound.

B. Retaining Wall

a. The external surface is prepared and approved cement slurry is applied.

b. Providing and laying 25mm thick cement mortar in 1:4 (1 cement : 4 coarse sand) mixed with approved water proofing compound in two layers with chicken wire mesh 26 or 24 gauge 25mm size in between the two layers.

c. The G.I. pipes are placed at 1.5m c/c in both directions, and, 0.75 m C/C along construction joints and securely fastened to the reinforcement prior to shuttering and concreting or alternately by drilling holes (25mm to 32mm dia) in the concrete upto a depth as shown in the drawing all over the wall surface @ 1.50mt. C/C and as shown in the drawing. Treatment along all construction joints by providing nozzles, as above, shall also be executed.

d. Fixing 25mm dia G.I. threaded nozzles in these holes with cement mortar 1:4 (1 cement: 4 coarse sand) mixed with water proofing compound.

e. Injecting cement grout of cement and polymer based water proofing compound (non-shrinkage grouting compound) in proportion as specified in these nozzles at a pressure of 2.5 to 3.0 Kg/Sq.cm.

f. After the grout the nozzles are cut and filled with cement mortar 1:2 mixed with polymer based water proofing compound in proportion as specified and finished smooth.

Note: The proportion of approved water proofing compound to be used in respect of ordinary cement shall be as per manufacturer’s specifications.

C. Guarantee for water proofing:

Work to be get executed through a approved specialized agency & covered by a 10 years guarantee by the main contractor against leakage, seepage and dampness etc. for which necessary performance guarantee for requisite indicated value of work shall be
furnished by the contractor before completion.

D. Measurements:

The length and breadth shall be measured correct to cm. The flooring area shall be measured in sq.ms. actually executed in raft slab. Inside wall surfaces of the basement upto ground level from top of raft slab shall be measured in sq.ms. Columns cross sections area not to be deducted from the plan area.

E. Rate:

Rates shall be inclusive of all operations including labour, material, T&P, scaffolding etc. complete. Nothing extra shall be payable on any account.

3. HERMETIC SLIDING DOORS/WINDOWS

The hermetic sliding doors/windows shall be of properties mentioned below:-

Canopy : coated steel plate, finished in RAL 9006 (aluminium coloured steel) with a sloping top.
Rail construction : aluminium profile, Metaflex system, one length
Door blades : 60 mm thick with 6 mm laminate hpl sandwich on both sides. The above panel will be framed in anodized aluminium profiles.
Gasket : on all 4 sides of the door blade is a special rubber gasket.
Opener : stainless steel lever handle on both sides
Window : 300mm x 300mm
Frame : single aluminium frame profile, fixed to finished wall, not wall surrounded
Automation : electric, type SDA-04, 230V
Safety : photocell in the frame
Switches : radar hand switch, foot switch
Lock : not provided, optional
Medical earthing : not provided, optional
Inside frame dim. : 1800/1500mm (w) x 2100 mm (h)
Clear opening : 1680/1380mm (w) x 2100 mm (h)

Technical information SDA-04

Control : Microprocessor-controlled and regulated electromechanical sliding door drive
Power supply : 1*230 Vac +15% / -20% or 1*110Vac +30% / -20%
Frequency : 50 / 60 Hz
Power Consumption :
  Minimal : 18W
  Maximal : 450W
Drive : 3 phase AC motor
Nominal Motor power : 90 W
Maximal Motor power : 90 W
Motor regulator : Microprocessor controlled motor driver
Maximum door weight : 250 KG
Maximum door width : 3500 mm
Slow speed (V Slow) : 20 -120mm / second
Starting speed (V start) : 20 – 220 mm / second
Opening speed (V open) : V slow - 800mm / second
Closing speed (V close) : V slow – 500mm / second
Pedestrian opening : 10% - 80% of the available door opening
<table>
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<th>Particulars</th>
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</thead>
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<tr>
<td>Sliding - Automatic - 1800x2100</td>
<td>Door shall be fully automatic hermetically sealed sliding door with lead insert/linning with view panel of size 400x400 on each leaf and with all accessories complete in all respects as per drawing, manufactures specification and direction of Engineer-in-charge.</td>
</tr>
<tr>
<td>Sliding - Manual - 1800x2100</td>
<td>Basic – Door panel, viewing window(300mm x 300mm), door track &amp; handle, wall covering frame</td>
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<td>Basic - Door panel, viewing window (300mm x 300mm), door track &amp; handle, wall covering frame</td>
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<td></td>
<td>Automation with options – Controller &amp; Motor, 2 radar switches, 2 Foot Switches &amp; photocell</td>
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<td>Sliding - Manual - 1500x2100</td>
<td>Basic – Door panel, viewing window(300mm x 300mm), door track &amp; handle, wall covering frame</td>
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4. **DOOR WINDOW FITTING**

All Door/Window fittings shall be as per schedule of item and of quality and design of sample, approved by Engineer-In-Charge.

(a) S.S. tower bolts shall be ISI marked with necessary screws etc. complete of size 300x10 mm & 150x10 mm
(b) Stainless steel Mini Pull Handle H-Type Handles with necessary screws etc. complete of size 155 x 12 mm
(c) Stainless steel double rod door stopper of approved quality & make with necessary screws etc all complete.
(d) 100 mm Stain less steel mortice latch and lock with six levers and a pair S.S. lever handles with necessary screws etc. complete (Best make of approved quality).
(e) SS sliding door bolts of approved design & make of size 250 x 16mm & 300 x 16 mm with nuts and screws etc. complete.
(f) S/S Hydraulic Door Closer Heavy Duty of approved design & make with accessories all complete up to satisfaction of EIC.
5. **FIRE CHECK DOORS:-**

F. **General:-**

   i. The door shall be procured from approved manufacturer of CPWD / CBRI. The fire and smoke / hot gases check door shall be conforming to IS-3614 (Part-II)). The manufacturer shall have a prototype door tested and certified by CBRI Roorkee, of 120 minutes fire rating confirming to BS : 476 part 22 & IS : 3614 Part II.

   ii. The fire and smoke / hot gases check door shall not collapse during the rated period of the fire under the specified fire conditions.

   iii. The fire and smoke / hot gases check door shall not allow the passage of hot gases or the flames through the rebate of the gap between the door frame and shutter or through the holes, developed in the shutter during fire.

   iv. **Material:** Door frames and shutter shall be made from materials specified in the bill of quantities.

   v. **Shop drawing:** The contractor shall submit including required designing shop drawing for doorframes, shutters complete with

      a. Plan, elevation with relative position of adjacent works
      b. Glazing details with type size and fixing
      c. Fitting and fixtures with type size, brand and fixing details.
      d. Finishing details.

   vi. **Sample Approval:** A sample of fire check door including fittings and fixtures, shall be fabricated as per the shop drawings approved by the Engineer – in – charge for final approval before under taking mass production/ fabrication

G. **Wooden Fire Doors & Frames**

   i. **Door Frames:** Door frames shall be manufactured from 2nd class teakwood (Ivory Coast) of section as per BOQ. It shall have heat activated intumescent fire seal strip of size 20mm x 4mm (for smoke seal) of approved make provided in grooves on all three sides of the frame. The frame shall be coated with one coat anti-termite fire retardant primer of approved brand. The frame shall be fixed with 8 nos. 100mm dia metal dash fasteners of approved brand and manufacture or as per direction of Engineer-in-charge.

   ii. **Door Shutter:**

      Fire door shall be fully insulated 55 mm thick wooden fire / smoke check door shutter using 31mm thick FR insulation with internal fascia of 9mm thick calcium silicate board having density not less then 950 Kg/cum on both sides and faced with 4mm thick commercial ply facing including 15X55 mm size hardwood beading with fire and smoke seal of size 10 X4 mm fitted along vertical and horizontal edges of the shutter. The complete door system should be capable to achieve Two hour fire rating in accordance with BS:476 Part 20 and IS:3614 part II. Rate to include 150x75mm Hardwood door frame duly embedded with Prom seal Intumescing Smoke Strip as per manufacturer's specification all complete. The door shutter shall also have a vision panel 6mm thk, 200mm x 300mm / 300mm x 300mm fire rated glass ( to be paid separately), surrounded with fire proof treated teakwood beading, all around complete

      1. With following fire rated fittings as per direction of the Engineer-In-Charge.
      2. Door Locks
      3. Glass (Wired) Vision Panel of size 200mm x 300mm
4. Glass (Wired) Vision Panel of size 300mm x 300mm
5. Door Closer
6. SS DOOR HANDLES 150 mm
7. SS TOWER BOLTS 300mm
8. Panic bars for S/L doors
9. Panic bars for D/L doors
10. External Trim for Panic Bar
11. Samples of material shall be got approved by EIC before installation of above.

H. **Metal Fire Doors & Frames:** These shall conform to the BOQ and CPWD specifications.

I. **Fire Doors & Fittings**

All work is to be carried out in accordance with relevant IS Code and specification for Fire Door & fitting as per IS: 3614 (Part I) – 1966 and direction of Engineer in charge. Door shall be fixed with fire rated hinges 5 Knuckle, 2 bearing butt hinges size 4" x 3” x 3mm, in SS 304 and in satin stainless steel, as per EN 1935, CE Marked.

i. **Mortice Lock:** -2 hrs., fire rated mortice lock with lever handle tested in accordance with BS: 476 Part 22. A minimum one year warrantee shall be provided. Mortice sash lock with internal thumb turn and external key operation with lever handles shall be provided.

ii. **Flush Bolts (For Double Door):** - 300mm concealed extended lever action flush bolts satin finish, fixed to top and bottom of the inactive blade shall be provided.

iii. **Automatic Door Closer:** - Dual adjustable speed automatic door closer with rack and pinion method, in conformance with BS:476 Part 22 (for fire rating) and BS EN1154 shall be provided. The door closer shall have minimum of one year warrantee.

iv. **Pull Handle:** 300mm long stainless steel grade 304 D type pull handle shall be fixed with necessary screws etc. complete. A minimum one year warrantee for the product shall be provided.

v. **Fire Rated Panic exit device:** - It shall be suitable for door weights upto 120kgs. The Panic bar as per door leaf (SINGLE LEAF/DUPLICATE LEAF) shall consist of Main Panic Latch component, End Component, Push bar, Striker Kit, end caps in Silver finish. Complete set with screws & fixing accessories, External trim, having fire rated door closer TS 71/68 rack and pinion door closer EN size ¾, with std. arm and with two independent closing valves and latching speed adjustable by arm. Full plastic cover. Silver finish. As per EN 1154 life cycle 500,000 with seals and door stopper. The device shall be complete in all respect and fixed as recommended by the manufacturers. A minimum one year warrantee for the product shall be provided.

vi. **Smoke Seals:** - Heavy duty smoke seals for smoke check doors shall be provided.

vii. **Acoustic Seals:** - Acoustic seals of appropriate design duly fixed in shutter as well as door frame shall be provided.

J. **Opening Width:** - Opening width of door mentioned in the drawings shall be width measured with both door shutters fully open in straight position.

K. **Measurement:** - The measurements shall be done as per BoQ.

L. **Testing:** - The Engineer – in – charge holds the right to get the door tested for fire rating at the cost of the contractor/vendor. In case the Engineer-in-charge desires to get the doors tested, then one door shall be selected at random out of the entire lot and shall be tested for two hour fire rating. The testing shall be got done from either CBRI, Roorkee or from any
other laboratory approved by the Engineer-in-charge. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by the contractor. In case the door fails to meet the requirement, the entire lot shall be rejected.

M. **Rates:** The rates shall be inclusive of all material, T&P, Labour, etc. complete including the cost of fittings, testing etc. as described above.

### 6. FLOORING:

a. The flooring in the building shall be as per the approved floor finish drawings and laid in such a way that limits in floor levels would not exceed the limits provided in the latest CPWD specifications or manufactures specifications.

b. Wherever Vitrified Tile flooring is done, it shall be with multi grade/range 1st Quality tiles.

c. Slope in floors shall be provided as per architectural drawings, else the levels at any place when checked over a distance of one meters in any direction should not show variation in floor level more than 3 mm.

d. Rate for the items of flooring is inclusive of provision of sunken flooring and finishing edges of the same in bath kitchen, toilets, cutting holes for traps/ pipes etc., and nothing extra shall be paid on this account unless otherwise specified.

e. Protective layer to be provided of any type of flooring and nothing extra shall be paid on this account.

### 7. RECTIFIED CERAMIC TILE FLOORING, DADO / SKIRTING / FACIA MATERIALS:

Rectified Glazed Ceramic floor tiles shall be of size 600x600 mm or more (thickness to be specified by the manufacturer), of 1st quality conforming to IS: 15622, of approved make, in colours White, Ivory, Grey, Fume Red Brown, laid on 20 mm thick cement mortar 1:4 (1 Cement: 4 Coarse sand), including grouting the joints with white cement and matching pigments etc., complete.

**PREPARATION OF SURFACE & LAYING:**

Sub grade concrete or RCC slab or side brick wall/ or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped. The bedding/backing for the tile shall be as specified and shall be applied and allowed to harden. The mortar shall be roughened with wire brushes or by scratching diagonal lines 1.5mm deep at 7.5mm center both ways. The back of tiles shall be buttered with a coat of grey cement slurry paste and edges with cement slurry and set in the bedding mortar. The tiles shall be tapped gently with wooden mallet and corrected to proper planes and lines. The tile shall be butt jointed in pattern and joints shall be as fine as possible. The top of skirting/ dado shall be truly horizontal and joints truly vertical. After a period of curing of 7 days minimum, the tiles shall be cleaned and shall not sound hollow when tapped. The surface during laying shall be checked with a straight edge 2 m. long. Where full size tiles cannot be fixed, these shall be cut/sawn to the required size & their edges rubbed smooth to ensure straight and true joints. Tiles shall enter not less than 10mm. under side skirting. After the tiles have been laid, surplus cement grout shall be cleaned off.

**MORTAR AND BEDDING:**

Cement mortar for bedding shall be of proportion specified in items schedule and shall conform to the specification for materials, preparations etc. as specified under cement
mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned of all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be even & smoothly spread over the base by use of screed battens to proper level or slope. Cement mortar of thickness and proportion as specified in the schedule for dado shall be applied to the wall after preparing the wall surface as specified under cement plaster as specified in schedule of quantities and brought to correct line and plumb and the surface left rough to receive the tiles.

FIXING OF TILES FOR FLOORING:

The tiles before laying shall be soaked in water as per manufacturer's specification and direction of Engineer In Charge. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles which are fixed on the flooring adjoining the wall shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Neat cement mortar grout 1:2, using fine sand (table III, zone-IV and as per I.S. 383 ) of honey like consistency shall be spread over the bedding mortar just to cover as much area as can be tiled within half an hour. The edges of the tiles shall be smeared with neat cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. The surface of the flooring during laying shall be frequently checked with a straight edge about 2M long to obtain a true surface with the required slope. The joints between tiles shall not exceed 1.00 mm. in width. The joint shall be grouted with /matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

FIXING TILES FOR DADO & SKIRTING/FACIA:

Ceramic Rectified tiles in skirting, riser of steps shall be of required sizes as per drawing detail (thickness to be specified by the manufacturer), with water absorption less than 0.08% and conforming to IS: 15622, of approved brand & manufacturer, in all colours and shade, laid with cement based high polymer modified quick set tile adhesive (water based) conforming to IS: 15477(Type-2 Adhassive), in average 6 mm thickness, including grouting of joints (Payment for grouting of joints to be made separately).

CLEANING:

After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting over shall be washed thoroughly clean. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust. It shall be removed only after completion of the construction work and just before the floor is used.

POINTING AND FINISHING:
The joints shall be cleaned off with wire brush to a depth of 3 mm. and all dust and loose mortar removed. Joints shall then be flush pointed and finished with cement of matching or approved shade pigment and floor kept wet for 7 days and then cleaned. Finished surface shall not sound hollow when tapped with a wooden mallet.

8. **PVC FLOORING**

PVC flooring material is normally used for covering floor from decorative point of view in residential and non-residential buildings. This material gives a resilient and non-porous surface which can be easily cleaned with a wet cloth as dust and grime do not penetrate the surface. Since a burning cigarette will damage the neat surface of the PVC sheet, special care should be taken to prevent burning cigarette stumps to come in contact with the PVC flooring materials.

It shall be laid on a base that is finished even and smooth such as concrete, metal or timber boarding. Unevenness or undulations in the base will show badly on the surface and are liable to damage the PVC sheets/tiles.

**Materials**

The PVC flooring material shall conform to IS: 3462. It may be in the form of tiles, sheets or rolls as specified. It shall consist a thoroughly blended composition of thermoplastic binder, filler and pigments. The thermoplastic binder shall consist substantially of one or both of the following:

(a) Vinyl chloride polymer  
(b) Vinyl chloride copolymer

**Thickness**

The preferred thickness of PVC tiles for normal floor covering shall be 1.5, 2.0, 2.5, 3.0 or 4.0mm.

Thickness of PVC sheets shall be measured with micrometer of Ratechet type or a dial gauge graduated to 0.02mm. The micrometer shall have flat bearing surfaces of at least 6.5mm diameter at both contract points.

For sheets and rolls the thickness of the specimen shall be measured at twenty scattered points.

For polystyrene wall tiles, the cavity depth of the test specimen shall be measured at five points taken at random on the rear surface of each tile with a suitable depth gauge.

The width of flooring sheets and rolling in continuous length shall be 1000, 1500 and 2000mm. When supplied in rolls the length of the rolls shall not be less than 10 metre.

The measurement shall be carried out with a travelling microscope or suitable scale graduated to 0.02mm. Each tile shall be measured for length and width at the three quarter point in each direction.

**Tolerance**

(a) Thickness + 0.15mm  
(b) Width
(i) 300mm square tiles   + 0.2mm  
(ii) 600mm square tiles   + 0.4mm  
(iii) 900mm square tiles   + 0.6mm  
(i)  Sheets and rolls   + 0.1 per cent

Adhesive Rubber based adhesives are suitable for fixing PVC flooring over concrete, wooden and metal sub-floors. PVA based adhesives shall be used for concrete and wooden sub-floors. PVA based adhesives are not suitable for metallic surfaces and also for locations where there is constant spillage of water.

Preparation of Sub-Floors Before laying PVC sheets/tiles, it is essential to ensure that the base is thoroughly dry and damp proof as evaporation of moisture cannot take place once the PVC flooring is laid. Moisture slowly damages the adhesive resulting in PVC sheet/tiles being separated from the base and curled up. In case of new work a period of 4 to 8 weeks shall be allowed for drying the sub-floor under normal conditions.

Concrete sub-floors on the ground floor shall be laid in two layers. The top of the lower layer of concrete shall be painted with two coats of A-90 gard (conforming to IS:1580) applied at the rate of 1.5 kg/Sm. The top surface of the lower layer shall be finished smooth while laying the concrete so that the bitumen can be applied uniformly. The bitumen shall be applied after the concrete has set and is sufficiently hard. Bitumen felt conforming to IS:1322 shall be sand-wiched in the sub-floor laid in two layers.

In new concrete floor, the smooth finish required shall be produced by using cement slurry spread on fresh concrete floor and finished smooth. If the concrete floor is old and surface not even, the surface should be made smooth by first cleaning it free of all foreign material and then a layer of cement mortar 1:2 (1 cement: 2 coarse sand) of average thickness of 6mm shall be applied on the surface finishing the surface smooth. The finished surface shall be cured for 7 days and then allowed to dry thoroughly.

Where it is expected that the dampness may find its way from the surrounding walls, the same shall also be effectively damp-proofed Up to at least 150mm above the level of the sub-floor and the damp-proof treatment below the floor shall be extended over the walls.

Laying and Fixing Prior to laying, the flooring tiles/rolls/sheets shall be brought to the temperature of the area in which it is to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours.

Where air-conditioning is installed, the flooring shall not be laid on the sub-floor until the conditioning units have been in operation for at least seven days. During this period the temperature shall neither fall below 20°C nor exceed 30°C. These conditions shall be maintained during laying and for 48 hours, thereafter.

Before commencing the laying operations, the sub-floor shall be examined for evenness and dryness. The sub-floor shall then be cleaned with a dry cloth. The PVC flooring shall not be laid on a sub-floor unless the sub-floor is perfectly dry.

The layout of the PVC flooring on the sub-floor to be covered should be marked with guidelines. The PVC flooring shall be first laid for trial, without using the adhesive, according to the required layout.
The adhesive shall be applied by using a notched trowel to the sub-floor and to the back side of the PVC sheet or tile flooring. When set sufficiently for laying, the adhesive shall be sticky to touch, but will not mark the fingers. In general, the adhesive will require about half an hour for setting. It should not be left after setting for too long a period as the adhesive properties will be lost owing to dust films and other causes.

Care should be taken while laying the flooring under high humidity conditions so that condensation does not take place of the adhesive. It is preferable to avoid laying under high humidity conditions.

The area of adhesive to be spread at one time on the sub-floor depends entirely upon local circumstances. In case of a small room, adhesive may be spread over the entire area but relatively small areas of tiles/ sheets flooring should be treated in a larger room.

When the adhesive is just tack free the PVC flooring sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface. After laying the sheet in position, it shall be pressed with suitable roller weighing about 5kg to develop proper contract with the sub-floor. The next sheet with its back side applied with the adhesive shall be laid edge to edge with the sheet already laid and fixed in exactly the same manner as the first sheet was fixed. The sheets shall be laid edge to edge so that there is minimum gap between joints.

The alignment should be checked after laying of each row of sheet is completed. If the alignment is not perfect, the sheets may be trimmed by using a straight edge.

The tiles shall be fixed in exactly the same manner as for the sheets. It is preferable to start laying of the tiles from the centre of the area. Care should be taken that the tiles are laid close to each other with minimum gap between joints. The tiles should always be lowered in position and pressed firmly on to the adhesive. Care should be taken not to slide them as this may result in adhesive being squeezed up between the joints. PVC tiles after laying shall be rolled with a light wooden roller weighing about 5kg to ensure full contact with the under layer. Any undulations noticed on the PVC surface shall be rectified by removing and relaying the tiles after thorough cleaning of the underside of the affected tiles. The adhesives applied earlier in such places shall be thoroughly removed by using proper solvents and the surface shall be cleaned to remove the traces of solvents used. Work should be constantly checked against guidelines in order to ensure that all the four edges of adjacent tiles meet accurately.

Any adhesive which may squeeze up between sheets or tiles should be wiped off immediately with a wet cloth before the adhesive hardens. If, by chance, adhesive dries up and hardens on the surface of the sheet or tile, it should be removed with a suitable solvent. A solution of one part of commercial butyleacetate and three parts of turpentine oil is a suitable solvent for the purpose.

A minimum period of 24 hours shall be given after laying the flooring for developing proper bond of the adhesive. During this period, the flooring shall not be put to service. It is preferable to lay the PVC flooring after completion of plastering, painting and other decorative finish works so as to avoid any accidental damage to the flooring.
When the flooring has been securely fixed, it shall be cleaned with a wet cloth soaked in warm soap solution (two spoons of soap in 5 litres of warm water).

Where the edges of the PVC sheets of tiles are exposed, as for example, in doorways and on stair treads, it is important to provide protection against damage of flooring materials. Metallic edge strips may be used and should be securely fastened to the sub-floor to protect edges of the flooring.

Precaution for Maintenance PVC flooring subject to normal usage may be kept clean by mopping with soap solution using a clean damp cloth. Water shall not be poured on the PVC flooring for cleaning purpose as the water may tend to seep through the joins and cause the adhesive to fail. To maintain a good wearing surface a good appearance, the flooring may be periodically polished. When polish is applied frequently, a thick layer builds up which collects dirt and dust and is tacky to walk on.

If the traffic is light, the floor shall be given frequent brushing regular polishing by an application of new polish every 4 to 6 weeks. Under moderate traffic conditions the floor shall be given an occasional wash with a wet mop but no detergents shall be used so that the polish is not removed.

Application of polish may be done every one to three weeks. PVC flooring should not be over waxed. When this condition develops, the coatings should be cleared off with white spirit or paraffin and a light even coat of polish applied. When the PVC flooring has been polished, it will remain bright for a considerable period if dry mop is applied each day. It is this daily ‘dry polish’ that maintains the glossy surface. After exceptionally heavy traffic PVC flooring should be swept with a hair groom, rubbed with a mop or cloth frequently rinsed in clean water and finally rubbed dry.

Measurements

Length and breadth shall be measured correct to a cm and its area shall be calculated in Sqm correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 Sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 Sqm. Nothing extra shall be paid for providing PVC flooring in borders and margins, irrespective of their width.

Rate

The rate shall include the cost of all materials and labor involved in all the operations described above, except those described. The rate does not include the cost of sub-floor or damp proof treatment, if any. It also does not include the cost of metallic edge strip to protect edge of flooring, wherever provided, it shall be paid separately.

1. PVC flooring shall be 1.83m wide & having a nominal total thickness of 2.2mm. The nominal thickness of the wear layer would be 2 mm. The product should have a conductive backing of 0.2mm. The wear surface shall consist of impregnated polyurethane homogeneous mixture of PVC, Plasticizers, Urethane, color pigments and filler calendared to form a sheet. Colors and pattern detail shall be dispersed throughout the thickness of the wear layer. It shall conform to Group P of Wear Resistance as per EN 649, Flammability of class Bfl-s1 as per EN 13501-1, Slip resistance of R9 as per BGR 181, Dynamic
**Installation:**

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be levelled by self-leveling compound. IPS/Vitrified/ceramic/mosaic tiles do not provide zero levelled sub floor. The moisture level present in the subfloor should be less than 8% before installation of the floor. The sheet should be laid using adhesive recommended by Armstrong. Each row of tiles/strip of floor covering must be linked crosswise with a continuous copper strip. Individual rows/strips must be at least 3 m² in size and linked to the rest of the area with a copper tape. In rooms of up to 40 m², connection points for equipotential bonding should be provided in at least one point in the room. In larger Rooms, several connection points must be used.

The complete work shall be undertaken as per the manufacturer's installation instructions and direction and complete up to satisfaction of Engineer in Charge.

2. PVC Sheet wall covering shall be, 1.5m wide, having a nominal total thickness of 1mm. The nominal thickness of the wear layer would be 1.25mm. The wear surface shall consist of impregnated polyurethane homogeneous mixture of PVC, Plasticizers, Urethane, color pigments and filler calendared to form a sheet. Colors shall be dispersed throughout the thickness of the wear layer. Wallflex shall conform to Group M of Wear Resistance as per EN 660-2, Fire resistance of group 2 as per AS/NZS3837, Residual indentation of ≤0.10mm as per EN433, curling after exposure to moisture ≤8mm as per EN434, Seam strength of mean≥240N/50mm as per EN684.

3. Properly shaped radius section at floor to floor to act as a supporting base for coved sheet vinyl flooring should be provided as per direction of Engineer in Charge.

4. Homogeneous pvc sheet of 2 metre wide and overall thickness of 2mm shall be laid. The product should be homogeneous and single layered. The wear surface shall consist of impregnated polyurethane homogeneous mixture of PVC with TRUESHIELD technology, Plasticizers without DOP, Urethane, colour pigments and filler calendared to form a sheet. Color and pattern details shall be dispersed throughout the thickness of the wear layer. Medintech Plus shall conform to group "T" wear resistance as per EN 649, Clean Room certified with class 'A' as per ASTM5100, Flammability resistance of class Bfl-s1 as per GB8624-2006, Dynamic coefficient of friction of class DS as per EN 13893, Thermal Resistance of 0.072m²K/W as per EN 12667, Thermal conductivity of 0.071W/mK as per EN12524, impact sound reduction of 3dB as per ISO 10140, Slip Resistance of class R9 as per DIN 51130, Residual indentation of 0.03mm or less as per GB/T 4085-2005, Color fastness rating of ≥6 as per ISO 105-B02, total weight being 3.3 kg/m² as per EN430. The product shall be suitable for applications in class 23/34/43 areas as per EN685. Product shall exhibit antistatic behaviour, resistance to bacteria, resistance to chemical, resistance to staining, suitability to castor chair. The product shall be Floor Score certified with no SVHC content published by European Chemicals Agency (REACH). Product shall contribute to LEED points under Indoor environmental quality (LEED EQ) and Material & Resource (LEED MR) category.
5. Modular Carpet Tile should be of size 50x50cm size, 100% manufactured in Europe, made using 100% Polyamide (also called Nylon) yarns, minimum pile weight of 540 GSM, minimum total weight of 4300 GSM, minimum pile height of 2.9mm and minimum total height of 6.4mm and minimum tuft density of 156000/m² and Castor Chair suitability of Class A (continuous use) as per EN 985.

The said modular carpet tile should have a minimum usage classification of Class 33 or better as per EN 1307, fire rating of Bfl-S1 or better as per EN13501-1, minimum color fastness rating to light to be >5-6 as per ISO 105-B02, and impact noise rating of >37dB as per ISO 10140. The said modular carpet tile should have antistatic rating of ≤2kV as per ISO 6356 and dimensional stability of max 0.2%, as per EN986

6. Laying of 2 - 3 mm average thick layer of cementations smoothening compound of UZIN NC 149 sh or equivalent as recommended by the Vinyl sheet flooring manufacturer over and including a priming compound of UZIN PE 360 sh or equivalent as recommended by the Vinyl sheet flooring manufacturer and installation team on concrete surface to provide a smooth & homogenous surface for laying of vinyl sheet flooring complete to the entire satisfaction of Engineer-in-charge.

9. 10 mm thick Heavy duty Paver Vitrified Tiles of size 300 x 300 mm in floors, jointed with neat cement slurry mixed with pigment to match the shade of the tiles, including rubbing and polishing complete, on 20 mm thick bed of cement mortar 1:4 (1 cement :4 coarse sand).

10. 10 mm thick acid and/or alkali resistant tiles of approved make and colour using acid and/or alkali resisting mortar bedding, and jointfilled with acid and/or alkali resisting cement as per IS : 4457, complete as per the direction of Engineer-in-Charge.

11. **Polycarbonate Sheet Roofing**

    Polycarbonate Roofing system, a complete assembly of extruded cellular structure UV protected polycarbonate panels incorporated into a complete system. Co-extruded UV protected polycarbonate panel system of minimum 12 mm thickness with panel width of 600 mm to ensure best performance for wind uplift, vibration, oil canning and visual appearance. Panels shall be manufactured with vertical standing seam with standing seam height of 10 - 15mm at both sides of the panel. Panels shall be of Softlite / Antiglare type to prevent glare. Panels shall be fixed on purlins with the Z - Type Stainless Steel Fastener/retention clips and connectors. Each fastener shall be min 1 mm thick of SS 304 Grade and secured to supporting frame/structure with min 3 numbers self-drilling screws so that the Pull-Out Load of Fastener exceeds 7000 N (7 `KN) when tested as per ISO 6892:1998 and IS 1608: 2005. Snap-on connectors to interlock the panels shall have 2-4 teeth grip-lock locking mechanism to ensure maximum uplift capability. Polycarbonate panels also shall not have Yellowness Index as per ASTM D 1925 of 15 units when tested on a sample exposed to UV for 500 Hours as per sASTM G 155. The polycarbonate panels must satisfy Dart drop impact test as per IS 14443-97 shall show no sign of breakage on Polycarbonate sheets which have been exposed to UV for a min.
of 500 Hours as per ASTM G 155. Panel shall be with additional End cap/Aluminum U / F Profile / Glazing Bar (mill finish) for ends as required. Panel shall be fixed over M S structural steel / MS purlin (paid separately) conforming to the detail technical specifications as per approved architectural drawings.

The work shall be carried out as approved and complete up to the satisfaction of Engineer in Charge.

12. **Armstrong Orcal Clip in metal ceiling System**

Providing & Fixing of Armstrong Orcal Clip in metal ceiling System consisting of 300x1200mm clip in tiles of pre coated Aluminium in 0.7 mm thickness with bevel edge in white colour with standard perforation of 1.5mm dia. The back of the tile should have black acoustical fleece. The NRC should be 0.70 and suitable for Green Building application, with Recycled content of 50%. Installation: To comprise 3000mm long ‘C’ channels spaced at 1200mm centres securely fixed to the structural soffit by support clamp & approved hangers. The last hanger at the end of each C channel should not be greater than 600mm from the adjacent wall. Use a C-channel connector for splicing two pieces of C-channels. 4000mm Dp-12 Main carriers (spring tee bars) shall be spaced at 1200mm centres in a direction perpendicular to the C-channels and shall be secured at every intersection with C channel using a dp-12 hanger. Use Dp-12 connector to splice two pieces of Dp-12 main carriers. Tiles should be clipped in between two Dp-12 carriers (spring tee bars) from below. Perimeter trims to be of Armstrong wall angles of white colour secured to walls at 450mm maximum centres. Cut tiles to be secured to the wall angles using a spring clamp.

13. **GRC JALI AND CLAY TILES**

**GRC JALI**

Work Includes G.R.C. brick tiles shall be of approved make for wall lining to be fixed with special adhesive like Araldite or equivalent over 10mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) including pointing in white cement with an admixture of pigment to match the stone shade.

<table>
<thead>
<tr>
<th>a) G.R.C. Band shall be of approved Pattern of Following Sizes as per Drawing and direction of Engineer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>For 300 mm width &amp; 250 mm depth</td>
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<tr>
<td>For 250 mm width &amp; 250 mm depth</td>
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<tr>
<td>For 200 mm width &amp; 250 mm depth</td>
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<thead>
<tr>
<th>b) Providing and fixing of GRC Crown of approved Pattern of Following Sizes as per Drawing and direction of Engineer in charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>300x1000x300 mm</td>
</tr>
<tr>
<td>200 x 750 x300 mm</td>
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<tr>
<td>150 x 600 x 300 mm</td>
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</tbody>
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<tr>
<th>c) Providing and fixing of GRC designed at columns base and loop as per Drawing and direction of Engineer-in Charge</th>
</tr>
</thead>
</table>
1400 mm dia

1000 mm dia

d) Providing and Fixing Of GRC Designed Moulding Of approved Design & Pattern as per Drawing and Direction of Engineer in Charge

<table>
<thead>
<tr>
<th>Dimension</th>
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<tbody>
<tr>
<td>1350 x 250 mm</td>
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<tr>
<td>1300 x 150 mm</td>
</tr>
<tr>
<td>1650 x 250 mm</td>
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<tr>
<td>1600 x 150 mm</td>
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</tbody>
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Dry Density : > 1800 kg/m³
Water Absorption : Less than 6% of dry weight by immersion over a period of 24 hours.
Compressive Strength : > 400 Kg. / CM² (M - 40 Grade)
Wet Transverse Strength : > 7 N/ mm
Abrasion Resistance : Less than 2.0 for E.H.D.
Thermal Conductivity : 1.63 W/MK at 3% moisture content
                      1.80 /MK at 5% moisture content

**CLAY TILES**

Clay tiles work for wall lining shall be done by approved quality and shade of clay tile with special adhesive like Araldite or equivalent over 10mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) including pointing in white cement with an admixture of pigment to match the stone shade.
The work shall be carried out complete as approved and Up to satisfaction of Engineer in Charge

13. PUFF CEILING PANELS

Puff Ceiling panels Shall be Constructed of 50 mm Thick PUF (Poly Urethane Foam) insulation & density Of 40 + 2 kg/m³ laminated with Pre---coated GI outside And SS 304 inside Of walls The top Coat of Panels shall Be Global White color. The Panels Are joined With tongue & Groove system Along with Cam locking arrangement.Finish of cell ceiling panels: Global white Color.Hardware--- The room Shall be Provided with U Channel, Internal and External flashing, Silicon Sealants, Rivets, Nuts, Bolts, et

14. AURA ASIPL OPEN CELL CEILING

AURA ASIPL open cell ceiling 100mm open cell ceiling with cell size of 100x100mm made out GI steel. The assembled cell ceiling panels shall be in size of 600x1200 made out of blades in 9mm (W) x 40mm (H). The assembled cell ceiling panels are then clipped into U---94 carriers in GI, pre---coated in black enameled finished at 1200mm c.c. Wire clips shall hold the cell ceiling panels into the U---94 carriers. Once the U---94 carriers are installed then primary angles made out of GMS, type U1040 are cross connected to the U---94 carriers at 1200mm c.c. for lateral bracing The whole ceiling
shall be suspended by M6 threaded rods installed 1200mm c.c. All panel modules must be hinge able through wire clips.

15. wooden false ceiling

Wooden false ceiling at all height using 4 mm thick veneer finish lamination sheet over 12 mm thick BWR grade ply as per design and pattern of Architectural drawing including providing and fixing of frame work made of special sections, power pressed from M.S sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the rate of 1200 mm centre to centre to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of 4mm thick vanner finish lamination and 12 mm thick BWR grade ply to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the ply with recommended jointing compound, jointing tapes, finishing with jointing compound in 3 layers covering upto 150 mm or both sides of joint and two coats of primer suitable for ply, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge

including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of 4mm thick vanner finish lamination and 12 mm thick BWR grade ply to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the ply with recommended jointing compound, jointing tapes, finishing with jointing compound in 3 layers covering upto 150 mm or both sides of joint and two coats of primer suitable for ply, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge

16. Polyurethane waterproofing system

Providing and applying single component based on pure polyurethane waterproofing system of approved make shall be applied directly above puff insulation/RCC slab consisting of PU primer followed by spray applied PU waterproofing applied at 1.8kgs per sqm evenly spread above puff insulation covering all horizontal and vertical areas. Product shall be applied in two-three coats as per site requirement. The product shall be taken minimum 300mm vertically areas above FFL(to be protected with single
component UV Top coat. Single component PU waterproofing shall have tensile strength of ≥4 MPa and elongation of ≥500% when tested as per ASTM D 412 and DIN 52455 respectively, crack bridging upto 2mm as per ASTM C 1305. At terminations it is recommended to use a 110g/sqmt geotextile as per manufacturer instructions. Roof Waterproofing, Insulation shall be sourced from single manufacturer and shall be applied by single application agency.

17. Mirror of superior glass (of approved quality) and of required shape and size with wooden moulded frame of approved make and design with 6 mm thick hard board backing:

18. Chicken Mesh of apature 25mm with 22 SWG wire on the junction of R.C.C work & brick work under the plaster by U nail. Complete as per direction of Engineer in charge.
1.0 SPECIAL CONDITIONS

1.1 Scope of work

1.1.1 The form of Contract shall be according to the "Conditions of Contract". The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2 Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialised services as described hereinafter and as specified in the Bill of Quantities and/or shown on the plumbing drawings.

1.1.3 Without restricting to the generality of the foregoing, the sanitary installations shall include the following:

1. Plumbing Works
   - Sanitary Fixtures & C.P Brass Fittings
   - Soil, Waste, Vent, Pipes & Fittings
   - Water Supply & Garden Irrigation System
   - Sewerage.
   - Storm Water Drainage.
   - Water Supply & drainage Pumps.
   - Water Treatment Equipments.
   - Sewage Treatment Plant.

2. Fire Fighting Works
   - Fire Hydrant System
   - Fire Sprinkler System
   - Fire Pump & Accessories
   - Fire Extinguishers

1.1.4 Services rendered under this section shall be done without any extra charge.

2. SPECIFICATIONS

2.1 Work under this Contract shall be carried out strictly in accordance with specifications attached with the tender.

2.2 Items not covered under these specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per specifications of the latest Central Public Works Department with up-to-date amendments as applicable in the Contract.

2.3 Works not covered under Para 2.1 and 2.2 shall be carried out as per relevant Codes & Bureau of Indian Standards and in case of its absence as per British Standard Code of Practice.

3. EXECUTION OF WORK

3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

3.2 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural, HVAC, electrical, structural and other specialised services drawings.
3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners as per approved make only.

3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the ENGINEER IN CHARGE. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of completion/commissioning along with the specified phasing, if any.

4. DRAWINGS

4.1 Contract drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the architectural and other services drawings.

4.2 Architectural drawings shall take precedence over plumbing or other services drawings as to all dimensions.

4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the ENGINEER IN CHARGE shall be final.

4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

5. INSPECTION AND TESTING OF MATERIALS

5.1 Contractor shall be required, to produce manufacturers test certificate for the particular batch of materials supplied to him. Contractor may be required to get the material tested from outside approved laboratory for confirmation of material as per ENGINEER IN CHARGE/Client instruction as and when required. The tests carried out shall be as per the relevant Bureau of Indian Standards.

5.2 For examination and testing of materials and works at the site contractor shall provide all testing and gauging equipment necessary but not limited to the following:

   a) Steel tapes
   b) Weighing machine
   c) Plumb bobs, spirit levels, hammer
   d) Micrometres
   e) Hydraulic

5.3 All such equipment shall be tested for calibration at approved laboratory, if required by the Project Manager. All testing equipment in charge shall be preferably located in special room meant for the purpose.

5.4 Samples of all materials shall be got approved by Architect/ENGINEER IN CHARGE and Client and should be first made of the approved make list before placing order and the approved samples shall be deposited with the Project Manager.

6. METRIC CONVERSION

6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

7. REFERENCE POINTS

7.1 Contractor shall provide permanent bench marks, flag tops and other reference points and check that with other agencies to confirm the same reference point for all the proper execution of work and these shall be preserved till the end of the work.
7.2 All such reference points shall be in relation to the levels and locations, given in the architectural and plumbing drawings.

8. REFERENCE DRAWINGS

8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.

8.3 On award of the work the contractor shall be issued four sets of consultant’s working drawings stamped “good for construction” by the Project Manager. The consultant’s drawings shall be the basis of contractor’s shop drawings. In addition, the Project Manager shall also be issue one copy of the Interior Designer’s; Electrical & HVAC approved shop drawings relevant to his work for coordination purpose.

8.4 Shop drawings are detailed working drawings which incorporate the contractor's details for execution of the work and incorporate engineer in chargeent manufacturer's details and dimensions to ensure that the same can be installed in the space provided.

8.5 All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully co-ordinated with other services and approved by the Project Manager before execution of the works. Project Manager shall arrange to issue two copies/prints of services drawings from the respective contracting agencies. All drawings will be valid only when stamped and issued by the ENGINEER IN CHARGE.

8.6 Shop drawings shall also be furnished for detailed layout of all engineer in chargeent, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

8.7 Six sets of manufacturer's engineer in chargeent drawings, roughing in and wiring diagrams shall be submitted.

8.8 Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.

8.9 Three copies of each set of shop drawings shall be submitted for initial scrutiny, discussion and approval.
8.10 Each submission shall be accompanied by contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and engineer in chargeent can be satisfactorily installed without any obstructions in the space available.

8.11 On approval of the above the contractor shall furnish six sets of the approved shop drawings for execution of the work.

9. COMPLETION DRAWINGS

9.1 On completion of work, Contractor shall submit one complete set of original tracings and three prints of "as built" drawings to the ENGINEER IN CHARGE duly approved and stamped by Consultant. These drawings shall have the following information.

a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

b) Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

c) Run of all water supply lines with diameters, locations of control valves, access panels.

d) Location of all mechanical engineer in chargeent with layout and piping connections and mechanical engineer in chargeent.

e) All shop drawings shall be updated from time to time for the purpose of making
Completion drawings.

No completion certificate shall be issued unless the above drawings are submitted.

9.2 Contractor shall provide four sets of catalogues, service manuals manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

9.3 All "warranty cards" given by the manufacturers shall be handed over to ENGINEER IN CHARGE.

10. CONTRACTOR'S RATES

10.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, all taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

10.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

10.3 All rates quoted must be for complete items inclusive of all such accessories, fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

10.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by the Project Manager. Contractor shall provide holes, sleeves, recesses in the concrete and masonry work as the work proceeds. All hot and cold water supply pipes crossing masonry walls and floors shall be provided with G.I. pipe sleeves. The annular space between the pipe and sleeve shall be filled up with fire proof sealant after testing. Contractor shall give the pipe sleeves to the civil contractor well in time so that the same can be fixed along with civil works. Any co-ordination gap shall be of Plumbing contractor's responsibility.

10.5 The Contractor shall furnish the ENGINEER IN CHARGE with vouchers & test certificates, to prove that the materials are as per the specification and to indicate that the rates at which the materials are purchased are in order to work out the rate analysis of non-tendered items which he may be called upon to carryout.

11. TESTING

11.1 Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

11.2 Tests shall be performed in presence of the Project Manager and test records for the tests shall be duly signed by Plumbing Consultant, Contractor and the ENGINEER IN CHARGE.

11.3 All materials and equipment found defective shall be replaced at contractor cost and whole work shall be tested to meet the requirements of the specifications.

11.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.

11.5 Contractor shall provide all labour, equipment in charge and materials for the performance of the tests at no extra cost.

12. SITE CLEARANCE AND CLEANUP

12.1 The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site. Failing of which attract penalties:

12.2 After the fixtures, equipment in charge and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints, stains, stickers and other foreign matter or discoloration leaving the same in a ready to use condition. The equipment in charge installed shall be protected by contractor till formal handing over takes place by Client.
12.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Project Manager at the Contractor’s risk and cost. Cost of the cleanup shall be deducted from the contractor's bills on pro-rata basis in proportion to his contract value.

13. LICENCE PERMITS AND AUTHORITIES

13.1 Contractor must hold a valid plumbing or any other licence as required by the municipal authority or other competent authority under whose jurisdiction the work falls.

13.2 Contractor must keep constant liaison with the local development Engineer in charge, municipal/statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.

13.3 Contractor shall obtain, from the municipal and other authorities ‘C’ & ‘D’ forms approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall re-imburse the fees paid to the authorities towards the connection charges a production of receipts for money paid.

13.4 Contractor shall get any materials tested from the appropriate authority if so required at no extra cost.

14. CUTTING OF WATER PROOFING MEMBRANE

No walls terraces shall be cut for making and opening after water proofing has been done without written approval. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Project Managers. Actual cost of any damage to finished work by contractor shall be recovered from Plumbing Contractor.

15. CUTTING OF STRUCTURAL MEMBERS

No structural member shall be chased or cut without the written permission of the Project Manager. Any damage to the structure shall be on contractor’s account.
SECTION - II SPECIFICATIONS FOR SANITARY FIXTURES & C.P BRASS FITTINGS

1 Scope of work

1.1 Work under this section shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings specified hereinafter and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-

a) Sanitary fixtures
b) Chromium plated fittings
c) Porcelain or stainless steel sinks
d) Accessories e.g. towel rods, toilet paper holders, soap dish, towel rack, coat hooks etc.

1.3 Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

1.4 All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

2 General requirements

2.1.1 Sanitary fixtures shall be of the best quality approved by the Architect / Consultant / ENGINEER IN CHARGE / Client. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / ENGINEER IN CHARGE / Client.

2.2 All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, screws and required connection pieces.

2.3 Fixing screws shall be half round head chromium plated brass screws with C.P. washers where necessary.

2.4 Contractor shall furnish without cost all such accessories and fixing devices that are necessary and required but not supplied along with the Plumbing Fixtures & CP Fittings by the manufacturers as a part of the original and standard supply.

2.5 All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer’s recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.

2.6 Contractor seal all fixtures fixed near wall, marble and edges. With an approved type of poly-sulphide sealant appropriate for its application.

3 European W.C

3.1 European W.C. shall be wash down or symphonic type wall mounted set flushed by means of dual flush Cistern systems which will be an integral part of the wall system. **Framework, walling and finishing will not form a part of the contractor’s work.** Where applicable flush pipe / bend shall be connected to the W.C. by means of a suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

3.2 Each W.C. set shall be provided with a plastic seat shall be with rubber buffers and chromium plated hinges.
3.3 Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Each W.C. shall be suitable for flushing in low volume of water 3-6 litres.

3.4 Flushing Cistern shall be provided with all internal flushing mechanism, 15 mm dia ball cock with unbreakable polythene float and overflow pipe. Any frame work required for fixing cistern has to be provided by the contractor.

3.5 Lavatory basin

3.5.1 Lavatory basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

3.5.2 Each basin shall be provided with brackets and clips of approved and securely fixed. Placing of basins over the brackets without secure fixing shall not be accepted.

3.5.3 Each basin shall be provided with 32 mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain as specified in the Bill of Quantities, 32 mm dia C.P. brass bottle trap with C.P pipe to wall and flange.

3.5.4 Each basin shall be provided with Mixer as specified in the Bill of Quantities.

3.5.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms or as directed by Project Manager.

3.6 Sinks

3.6.1 Sinks shall be white glazed fireclay or vitreous china or stainless steel or any other material as specified in the Bill of Quantities.

3.6.2 Each sink shall be provided with brackets of approved and securely fixed. Counter top sinks shall be fixed with suitable brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40 mm dia C.P. waste with chain and plug as given in the Bill of Quantities. Fixing shall be done as directed by Project Manager.

3.6.3 Supply fittings for sinks shall be mixing fittings or C.P. taps as specified in the Bill of Quantities.

3.7 Toilets for Disabled

3.7.1 Where specified in washroom facilities designed to accommodate physically handicapped, accessories should be provided as directed by the Project Manager.

3.7.2 Stainless steel grab bars of required size suitable for concealed or exposed mounting and non-slip gripping surface shall be provided in all washrooms to be used by physically handicapped as directed by the Project Manager.

3.8 Shower set

3.8.1 Shower set shall comprise of single lever shower mixer/ wall mixer, C.P. shower arm with wall flange and shower head of approved quality or as specified in the Bill of Quantities.

3.8.2 Shower mixer and shower arm shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

3.9 Urinals

3.9.1 Urinals shall be white glazed vitreous china of size, shape and type specified in the Bill of Quantities.

3.9.2 Bowl urinals shall be provided with 15 mm dia C.P. spreader, 40 mm dia stainless steel domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by C.I. brackets and C.I. wall clips as recommended by manufacturers complete as directed by Owner’s Site Representative.
3.9.3 Urinals shall be fixed with C.P. brass screws and shall be provided with 32 mm dia domical waste leading to urinal’s trap.

3.9.4 Flush pipes shall be G.I. pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Bill of Quantities.

3.9.5 Urinals shall be flushed by means of fully automatic no-touch flush valve with solenoid valves.

3.9.6 Waste pipes for urinals shall be G.I pipes (Medium class) to IS: 1239. Waste pipes may be exposed on wall or concealed in chase as directed by the Specifications for waste pipes shall be same as given in Section V.

3.10 Urinal partitions

3.10.1 Urinal partitions shall be white glazed vitreous china, marble, granite or any other material selected by the Owner’s Site Representative. The same shall be fixed by Contractor executing the finishing work. The exact location shall however be co-ordinated by the Plumbing Contractor.

3.10.2 Urinal partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. Clips as recommended by the manufacturer and directed by Owner’s Site Representative.

3.11 Accessories

3.11.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings or directed by the Project Manager.

3.11.2 All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Project Manager.

3.11.3 Recessed porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work as per Interior Designer’s drawings.

3.12 CP brass Angle Valve with PVC flexible connections 1.5m long

3.12.1 The C.P. brass Angle Valve shall be 15 mm dia. of best quality as approved by the Engineer-in-charge. The Angle Valve shall conform to I.S. 8931-1993.

3.12.2 The C.P. brass Angle Valve shall be fixed as directed to 15 mm dia. CPVC. at one end and PVC flexible connection with brass check nut on the other end.

3.12.3 The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.12.4 The rate shall be for a unit of one number.

3.13 C.P. brass towel rail

3.13.1 The C.P. brass towel rail shall be 600x20 mm. of best quality as approved by the Engineer-in-charge. The bracket shall be of C.P. brass. The rail shall conform to I.S. 1068-1958.

3.13.2 The bracket of the towel rail shall be fixed by means of C.P. brass screws wooden plugs finely embedded in the wall with C.M. 1:3(1 cement: 3 coarse sand). The towel rail shall be fixed as and where directed.

3.13.3 The rate includes cost of all labour, materials, tools and plant etc. for satisfactory completion of this item.

3.13.4 The rate shall be for a unit of one number.

3.14 CP Brass Soap Dish

3.14.1 The C.P. brass Soap Dish shall be of best quality as approved by the Engineer-in-charge.

3.14.2 The C.P. brass Soap Dish shall be fixed by means of C.P. brass screws wooden plugs finely embedded in
3.14.3 The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.14.4 The rate shall be for a unit of one number.

3.14 CP Brass Liquid Soap Dispenser

3.14.1 Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only by key provided. Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container. The valve shall operate with less than 2.27 Kg (5 lbs) of force.

3.14.2 The C.P. brass Liquid Soap Dispenser shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1:3(1cement:3coarse sand). The towel rail shall be fixed as and where directed.

3.14.3 The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.14.4 The rate shall be for a unit of one number.

3.15 Fully automatic "NO TOUCH" durable & shock proof hand drier

3.15.1 The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position. The hand drier shall be fully hygienic, rated for continuous repeat use (CRU). The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds. The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply directly plugged to power point complete in ABS plastic body having drying time 20-30 seconds complete as per direction of Engineer in Charge.

3.15.2 The Hand Drier shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1:3(1cement:3coarse sand). The towel rail shall be fixed as and where directed.

3.15.3 The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.15.4 The rate shall be for a unit of one number.

3.16 32mm dia. C.P. brass waste for sink

3.16.1 The C.P. brass waste trap and union shall be of 12 mm dia. and of best quality and make as approved by the Engineer-in-charge.

3.16.2 C. P. brass waste trap and union shall be connected to 32 mm. dia. waste pipe which shall be suitably bent towards the wall and which shall discharge into drain through a floor trap. The C. P. brass waste trap shall be provided for wash basin or sink as the case may be.

3.16.3 The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.16.4 The rate shall be for a unit of one number.

3.17 CP Brass Sink mixer

3.17.1 The C.P. brass Sink Mixer shall be 15 mm dia. with casted swinging spout of best quality as approved by the Engineer-in-charge.

3.17.2 The C.P. brass sink mixer shall be fixed as directed to 15 mm dia. CPVC Pipe at one end.

3.17.3 The rate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.
3.17.4 Therateshallbeforaunitofonenumber.

3.18 **Health faucet with regulator**

3.18.1 TheHealth Faucetshallbe15mm dia.of bestqualityasapprovedbytheEngineer-in-charge.

3.18.2 TheHealth Faucetshallbefixedasdirected to 15mm dia. CPVC Pipe at one end.

3.18.3 Therateincludescostofalllabour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.18.4 Therateshallbeforaunitofonenumber.

3.19 **Hand Rail**

3.19.1 The C.P. brass handrail shall be 600x20 mm of best quality as approved by the Engineer-in-charge. The brackets shall be of C.P. brass. The rail shall conform to I.S. 1068-1958.

3.19.2 The brackets of the hand rail shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1:3 (1 cement : 3 coarse sand). The towel rail shall be fixed as and where directed.

3.19.3 Therate includes cost of all labour and materials, tools and plant etc. required for satisfactory completion of this item.

3.19.4 Therateshallbeforaunitofonenumber.

3.20 **S.S. hinged grating**

3.20.1 The 100mm dia. S.S. hinged gratings for Floor trap shall be of best quality and make as approved. The frame of the grating shall be minimum 6mm thick.

3.20.2 The S.S. gratings shall be provided to P trap as the case may be in best workman like manner.

3.20.3 Therate includes cost of all labour and materials, tools and plant etc. required for satisfactory completion of this item.

3.20.4 Therateshallbeforaunitofonenumber.

3.21 **CP Brass Robe Hook**

3.21.1 The C.P. brass Robe Hook shall be of best quality as approved by the Engineer-in-charge.

3.21.2 The C.P. brass Robe Hook shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1:3 (1 cement : 3 coarse sand). The towel rail shall be fixed as and where directed.

3.21.3 Therate includes cost of all labour, materials, tools and plant etc. required for satisfactory completion of this item including threaded jointing with Teflon tape and testing.

3.21.4 Therateshallbeforaunitofonenumber.

3.22 **Final Installation**

The contractor shall install all sanitary fixtures and fittings in their position in accordance with approved trial assemblies and as shown on drawings. The installation shall be completed with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the
joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that the necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

3.23 Protection against Damage

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handling over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

3.24 Measurement

3.24.1 Sanitary fixtures and accessories shall be counted by numbers in the unit given in the Bill of Quantities.

3.24.2 Rates for all items shall be inclusive of cutting holes and chases and making good the same, C.P Brass screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.
SECTION:: III - SPECIFICATIONS FOR SOIL, WASTE, VENT & RAINWATER PIPES & FITTINGS

1. Scope of work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment in charge and appliances necessary and required to completely install all soil, waste, vent rain water pipes and fittings as required by the drawings, and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the soil, waste, vent pipes system shall include the following:-

a) Horizontal soil, waste and vent pipes, and fittings, joints, clamps, connections to fixtures.

b) Floor and urinal traps, cleanout plugs, inlet fittings.

c) Testing of all pipe lines.

2. General requirements

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps intervals specified.

2.5 Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawing so that other agencies are instructed to provide the same well in advance.

3. Piping System

3.1 Schedule of Pipes Use

1. CI Hubless Pipes Horizontal Soil, Waste. Vent &Waste Connection from Fixtures With in toilets, up to Stacks.

2. CI Hubless Pipes Vertical Soil, Waste. Vent Stacks up to GT/MH.

3. uPVC Pipes Conforming to IS: 4985, For Rain water System.

3.2 Soil, Waste & Vent Pipes

a) The Soil & Waste Pipe System above ground has been planned as a "two pipe system" as defined in IS codeshaving separate pipes for waste for kitchen sinks, bath tubs, showers, washbasins, condensate drains and floor drains and is approved by Project Manager.

b) Vertical soil & waste stacks shall be connected to a horizontal Soil and Waste Pipe as shown on the drawings.

c) Toilet layouts have been so arranged that the W.C. outlets shall be with "P" trap above ground.
3.3 CI Hubless Soil, Waste & Vent Pipes

All Soil, Waste & Vent Pipes used in building shall be CI Hubless pipes with epoxy coating inside and outside as specified above as per IS 1590.

All pipes shall be straight and smooth from inside free from cracks and other manufacturing defects.

3.4 Tolerances

Acceptable tolerance for pipes shall be as given in the relevant Indian standard.

3.5 Fittings

3.5.1 Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

3.5.2 Fittings shall be of the required degree of curvature with or without access door.

3.6 uPVC Rain Water Pipes

a) All Rain Water Pipes used in building shall be uPVC pipes as specified below.

b) All pipes shall be straight and smooth from inside free from cracks and other manufacturing defects.

c) uPVC Pipes & Matching Fitting shall be conforming to IS 4985 or BS: 4514.

3.7 Fittings

3.7.1 Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

3.7.2 Fittings shall be of the required degree of curvature with or without access door.

3.7.3 Access door shall be made up uPVC access door with cap jointing with solvent cement joint. The fixing shall be air and water tight.

3.8 Fixing

3.8.1 All vertical pipes shall be fixed by approved clamps and galvanised angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

3.8.2 Horizontal pipes running along ceiling shall be fixed on galvanised structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

3.8.3 Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

3.9 Clamps

3.9.1 All pipe clamps, supports and hangers shall be galvanised. Factory made Pre-fabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanise them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanised.

3.9.2 Clamps shall be of approved designs and fabricated from GI flats (which shall be galvanised after fabrication) of thickness and sizes as per drawings or contractor’s shop drawings. Clamps shall be fixed in accordance to manufacturer’s details/shop drawings to be submitted by the contractors.

3.9.3 When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanised expansion anchor fasteners (Dash fasteners) of approved design and size according to load.
3.9.4 Structural clamps e.g. trapeze or cluster hangers shall be fabricated by electro-welding from M.S. Structural members e.g. rods, angles, channels flats as per Contractors shop drawing shall be galvanised after fabrication. All nuts, bolts and washers shall be galvanised.

3.9.5 Galvanised slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in Bill of Quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

3.10 Traps

3.10.1 Floor traps

Floor traps where specified shall be siphon type full bore P or S type PP traps having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cms of the required depth.

3.10.2 Floor Trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type of floor or manhole inlet fitting fabricated from GI pipe without, with one, two or three inlet sockets welded on side to connect the waste pipe or joint between waste and inlet socket. Inlet shall be connected to a CI P or S trap. Floor trap inlet and the traps shall be set in cement concrete blocks where varied in floors as specified without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Project Manager.

3.10.3 Floor Trap Grating

Floor and urinal traps shall be provided with 100 -150mm square or round Stainless Steel gratings as approved with frame and rim of approved design and shape or as specified in the Bill of Quantities approved by the Project Manager.

3.11 Cleanout plugs

Clean out plug for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, “Ys” and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be lead caulked to the drain pipes.

3.12 Waste pipe from appliances

3.12.1 Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of GI pipes conforming to IS: 1239 in typical Toilets kitchens, pantries etc. as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be lead caulked to the drain pipes.

3.13 Encasing in Cement Concrete

3.13.1 Encasing of pipes is required to provide stability to the line and prevent its damage during construction.
Polypropylene Pipes under floor

Pipes lay in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 12 mm size) 75 mm in bed and all round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m.

3.14 Cutting and making good

3.14.1 Contractor shall provide all holes cut outs and chases in structural members necessary and required for the pipe work as building work proceeds. Wherever cut outs, holes are left in the original construction, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

3.15 Sleeves/ Cut-outs.

3.15.1 Contractor shall utilise all cut out and sleeves provided during construction to prevent breaking. The annular space between the pipe and the sleeve shall be filled up with approved type of fire retardant sealant. When sleeves are misplaced or inaccurately located contractor shall make the holes in the wall or structural members at his own cost but only with the prior permission of the Project Manager.

3.16 Testing

3.16.1 Testing procedure specified below apply to all soil, waste and vent pipes above ground.

3.16.2 Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests.

3.16.3 All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

3.17 Measurements

3.17.1 General

a) Rates quoted for all items shall be inclusive of all work and items given in the Specifications and Bill of Quantities.
b) Rates are applicable for the work in basements, underground, floors, in shafts at ceiling level area for all depths and building up to 45 m in height.

3.17.2 Rates are inclusive of cutting holes and chases in RCC and masonry work where no sleeves or cut outs have been provided during construction and making good the same.

3.17.3 Rates are inclusive of pre testing, on site testing, of the installations, materials and commissioning of the works.

3.17.4 Pipes (unit of measurement linear meter to the nearest centimetre).

3.17.5 Soil, waste, vent, anti-siphon age, rain water pipes, shall be measured net when fixed correct to a centimetre including all fittings along its finished length.

3.17.6 All supports required to support the pipes from slab/ceiling/i/c dash fasteners, GI structural, slotted angles/channels including support bolts and nuts embedded in masonry walls and hangers etc shall be included in the item rate of pipe including the item of work given below:-

a) Expandable anchor fasteners
b) Galvanising of all supports and hangers
c) Cutting holes in walls, ceiling of floors and making good where permitted
c) Nuts, bolts and washers for fixing and assembling

d) Wooden/PVC pipe saddles for vertical or horizontal runs

3.17.7 Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centring cutting complete as described in the relevant specifications.

3.17.8 Fittings (excluding pipe fittings) shall be measurement by numbers.

   Urinal traps, trap gratings, hoppers, cleanout plugs, khurras shall be measured by number per piece and shall include all items described in the relevant Specifications and Bill of Quantities.

3.18.10 **Excavation for soil pipes**

   No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for cast iron soil and waste pipes laid below ground, in sunken slabs or over basement rafts or for drainage pipes laid below ground.
SECTION :IV  -SPECIFICATION FOR WATER SUPPLY SYSTEM

1   Scope of work

1.1 Work under this section consists of furnishing all labour, materials and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

a) Distribution system from main vertical stack to all fixtures and appliances for cold & hot water.

b) Pipe protection and painting.

c) Control valves

2   General requirements

2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

2.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.6 Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

2.7 All pipe clamps, supports, nuts, bolts, washers shall be galvanised MS steel throughout the building. Painted MS clamps & MS nuts, bolts & washers shall not be accepted.

2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3   Water Supply System

3.1.1 Contractor should study the site plan and water supply system diagram for an overview of the system.

3.1.2 It is proposed to provide dual flushing cistern for all WCs.

3.1   Piping System

Schedule of Pipes Use

1. Stainless Steel 316 Grade

2. CPVC Pipes

   Domestic, Hot Water, Hot water Return, RO Water Supply inside Toilets, Horizontal and Vertical piping

   Flushing Water Supply inside Toilets, Horizontal and Vertical piping
4. Stainless Steel Grade-316 Pipes & Fittings

All cold & hot water pipes used in the Building shall be SS-316 pipes.

4.1 MATERIAL

4.1.1 Pipes used in wall chases within toilets & Kitchen, inside shafts, at terrace and in basement and all horizontal piping for domestic, hot water, hot water return and RO Water Supply shall be Stainless Steel pipes confirming to EN 10312 (S.S.Grade-316) complete with Press Type fittings.

4.1.2 Pipes used in wall chases within toilets inside shafts, at terrace and in basement and all horizontal piping for flushing water supply shall be CPVC pipes confirming to IS:15778:2007 and ASTMF-441 Schedule 40 complete with SDR 11 fittings.

4.2 INSTALLATIONS

4.2.1 Install product according to Manufacturer installation instruction and manual and follow recommended safe works practices.

4.2.2 Keep pipe and fitting in original packaging until needed and store pipes in covered areas.

4.2.3 Use tools designed for use with SS pipe and fitting.

4.2.4 Cut of minimum 25mm beyond the edge of the crack in case any crack is discovered in the pipe.

4.2.5 Cut the pipe as square (perpendicular) as possible before making joint. Always use sharp edge cutting tools. Sharpen holder tools periodically.

4.2 Valves

All Valves shall Ball Valve or butterfly valve as per bill of quantities.

4.3 Pipe Supports

4.3.1 All pipes clamps, supports, hangers, rods, pipe supports, nuts bolts & washers shall be factory made galvanised or alternatively galvanised after fabrication to suit site requirements.

4.3.2 Stainless Steel and CPVC Pipes in shafts and other locations shall be supported by galvanised clamps of design approved by Pipes in wall chases shall be anchored by G.I. hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. Structural. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.

Supports should be as per the below mentioned table:

<table>
<thead>
<tr>
<th>Size of Pipe</th>
<th>21°C</th>
<th>49°C</th>
<th>71°C</th>
<th>82°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inch</td>
<td>Ft.</td>
<td>Ft.</td>
<td>Ft.</td>
<td>Ft.</td>
</tr>
<tr>
<td>½”</td>
<td>5.5</td>
<td>4.5</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>¾”</td>
<td>5.5</td>
<td>5.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>1”</td>
<td>6.0</td>
<td>5.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>1¼”</td>
<td>6.5</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>1½”</td>
<td>7.0</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>
### 4.4 Anchor Fasteners

4.4.1 All pipes supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

### 4.5 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

### 4.6 Flanges

Flanged connections shall be provided on pipes as required or where shown on the drawings, all connections as necessary and required or as directed by Connections shall be made by the correct number and size of GI nuts, bolts & washers with 3 mm thick gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780. And C.I. butterfly valve to IS: 13095.

### 4.7 Trenches

All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

<table>
<thead>
<tr>
<th>Dia of pipe</th>
<th>Width of trench</th>
<th>Depth of trench</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 mm to 50 mm</td>
<td>30 cms</td>
<td>75 cms</td>
</tr>
<tr>
<td>65 mm to 100 mm</td>
<td>45 cms</td>
<td>100 cms</td>
</tr>
</tbody>
</table>

### 4.8 Sand filling

CPVC and Stainless Steel Pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches.
4.9 INSULATION

4.9.1 All hot water pipes shall be insulated with elastomeric closed shells circular pipes.

4.9.2 Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/moK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft²-oF/inch) at an average temperature of 30oC. The product shall have temperature range of –40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10-14 Kgs / m.sec.Pa).

4.9.3 The insulation material having the property of resistance of fire i.e. in case of fire these materials do not drop and do not spread flames.

4.9.4 All insulation material as per din 1988/7 (standard for drinking water pipe installation and for avoiding corrosion damage and scale formation).

4.9.5 The Thickness of insulation pipes as follows:

<table>
<thead>
<tr>
<th>Size of pipes</th>
<th>Application of pipes</th>
<th>Location</th>
<th>Thickness of Material (mm)</th>
<th>Type of Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 mm to 40mm</td>
<td>Hot water supply</td>
<td>Concealed</td>
<td>6 mm</td>
<td>Tube Section</td>
</tr>
<tr>
<td>15 mm to 100 mm</td>
<td>Hot water supply</td>
<td>Exposed</td>
<td>9 mm</td>
<td>Tube Section</td>
</tr>
</tbody>
</table>

4.10 Valves

4.10.1 Ball Valves

Valves upto 40 mm dia. shall be screwed type Ball Valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm², and accompanying couplings and steel handles (to BS 5351) with operating pressure not less than 16 Kg/Sq.cm (PN 16).

4.11 Butterfly Valves

4.11.1 Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

4.11.2 Butterfly valve shall be of best quality conforming to IS: 13095 with operating pressure not less than 16 Kg/Sq.cm (PN 16).

4.12 Non Return Valve (Slim Type)

Where specified non return valve (dual type check valve) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality with operating pressure not less than 16 Kg/Sq.cm (PN 16).

4.12.1 Each Butterfly and dual plate Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanised nuts, bolts and washers of correct length.

4.13 Testing

4.13.1 All pipes, fittings and valves after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 16 kg/cm² whichever is more.

Pressure shall be maintained for a period of at least two hours without any drop.

A test register shall be maintained and all entries shall be signed and dated by Contractor (s) and Project Manager.
4.13.2 In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.

4.13.3 After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

4.14 Measurement

All pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports. No allowance shall be made for the portions of pipe length entering the sockets of the adjacent pipe or fittings.

All supports required to support the pipes from slab/ceiling/i/c dash fasteners. GI. structural, slotted angles/channels including support bolts and nuts embedded in masonry walls and hangers etc shall be incl. in the item rate of pipe including the item of work given below:-

a) Expandable anchor fasteners
b) Galvanising of all supports and hangers
c) Cutting holes in walls, ceiling of floors and making good where permitted
d) Nuts, bolts and washers for fixing and assembling
e) Wooden/PVC pipe saddles for vertical or horizontal runs

Jointing with Teflon tape, white lead and insertion gasket of appropriate temperature grade.

Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.

Excavation, back filling, disposal of surplus earth and restoring the ground & floor in original condition.

4.15 Pipe Supports.

4.15.1 Rate quoted for supports & hangers shall be inclusive of:-

a) Expandable anchor fastens.
b) Galvanising of all supports & hangers.
c) Cutting holes in walls, ceilings on floors and making good where permitted.
d) Nuts, bolts and washers for fixing and assembling.
e) Wooden/PVC pipe saddles for vertical or horizontal runs.

4.16 Valves

Gunmetal, cast iron, butterfly and non-return valves and puddle flanges shall be measured by numbers and shall include wheels/caps, GI nuts, bolts, washers and insertion gasket.

4.17 Painting / pipe protection/insulation

Painting / pipe protection / insulation for pipes shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.
SECTION-V. SPECIFICATION FOR SEWERAGE AND DRAINAGE SYSTEM

a) Sewer lines including excavations, pipe lines, manholes, drop connections

b) Storm water drainage, excavation, pipe lines.

c) Drainage lines and open drains shall be laid to the required gradients and profiles.

d) All drainage work shall be done in accordance with the local municipal bye-laws.

e) Location of all manholes, etc. shall be got approved from the Project Manager. No drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager.

5. Excavation

5.1 Alignment and grade

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Project Manager. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Project Manager.

5.2 Opening out trenches

In excavating the trenches, etc. The solid road metalling, pavement, kerbing, etc. And turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Project Manager.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Project Manager.

5.3 Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Project Manager.

5.4 Removal of filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.

5.5 Excavation to be taken to proper depths

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given in the sections.

5.6 Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The back filling up to 75 cms above the crown of the sewer pipe shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Project Manager.
5.7 **Contractor to restore settlement and damages**

The Contractor shall, at his own costs and Charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and Charges, repair and make good any damage done to buildings and other property. If in the opinion of the Project Manager.

5.8 **Disposal of surplus soil**

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

5.9 **Width of trench**

Recommended width of trenches at the bottom shall be as follows:-

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Width (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>55</td>
</tr>
<tr>
<td>150</td>
<td>55</td>
</tr>
<tr>
<td>225-250</td>
<td>60</td>
</tr>
<tr>
<td>300</td>
<td>75</td>
</tr>
<tr>
<td>400</td>
<td>80</td>
</tr>
<tr>
<td>600</td>
<td>100</td>
</tr>
</tbody>
</table>

5.10 **RCC pipes**

All pipes shall be centrifugally spun RCC pipes NP2. Pipes shall be true and straight with uniform bore throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS:458-1971.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

**Laying**

RCC spun pipes shall be laid on cement concrete bed of cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on ‘the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.

**Jointing**

Semi flexible type collar joint.

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cement mortar added until the space of the collar has been filled completely with tightly caulked mortar. Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

**Curing:**
The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

Cement Concrete for Pipe Supports:

a. Unless otherwise directed by the Project Manager cement concrete for bed, all round or in haunches shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>upto 1.5 m depth</th>
<th>upto 3 m depth</th>
<th>beyond 3 m depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoneware pipes buried in open ground (no sub soil water)</td>
<td>All round (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
</tr>
<tr>
<td>RCC or SW in sub soil water</td>
<td>All round (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
<td>In Haunches (1:3:6)</td>
</tr>
<tr>
<td>PVC / HDPE pipe</td>
<td>All round (1:2:4)</td>
<td>In Haunches (1:4:8)</td>
<td>In Haunches (1:4:8)</td>
</tr>
<tr>
<td>CI Pipes (in all conditions)</td>
<td>All round (1:4:8)</td>
<td>In Haunches (1:4:8)</td>
<td>In Haunches (1:4:8)</td>
</tr>
<tr>
<td>All pipes under building</td>
<td>All round (1:2:4)</td>
<td>All round (1:2:4)</td>
<td>All round (1:2:4)</td>
</tr>
</tbody>
</table>

b. Pipes may be supported on brick masonry or precast RCC or in situ cradles. Cradles shall be as shown on the drawings.

c. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

Measurement:

a. Excavation

Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. RCC pipes shall be measured for length of the pipe line per linear meter.

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

5.11 Gully traps

a) Gully traps shall be of the same quality as described for stoneware pipes in clause 5.2 above and used where shown on drawings.

b) Gully traps shall be fixed in cement concrete 1:4:8 mix and a brick masonry chamber 30x30 cms inside in cement mortar 1:5 with 15x15 cms grating inside and 30x30 cms C.I sealed cover and frame weighing not less than 7.0 kg (approx.) to be constructed as per standard drawing.

5.12 Salt Glazed Stoneware Pipes

Stoneware pipes shall be new and of First Class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall comply with IS:651 and have the manufacturers name marked on them.

Laying of Salt Glazed Stoneware Pipes:
Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch, each pipe shall be examined carefully on arrival at site. Each pipe shall be lightly struck with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes shall be segregated, marked in a conspicuous manner and their use in the works prevented by expeditiously removing them from the work site.

The pipes shall be laid with sockets leading uphill and shall rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipes laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried to low it shall be made up with cement concrete 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate 20mm nominal size) at the Contractor's cost and charges.

**Jointing of Salt Glazed Stoneware Pipes:**

Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be of 45 degrees with the barrel of that pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

After the joint has been made any extraneous materials shall be removed from the inside of the joint with a suitable scarper of "badger". The newly made joints shall be protected until set, from the sun, drying winds, rain or dust. Sackling or other materials which can be kept damp shall be used. The joints shall be exposed and space left all around the pipes for inspection by the Project Manager. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

5.13 Manholes and chambers

5.13.1 All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Bill of Quantities.

5.13.2 All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Bill of Quantities or shown on the drawings.

5.13.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) as per standard details.

5.13.4 All manholes shall be plastered with 12/15 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster mixed with waterproofing compound.

5.13.5 All manholes with depths greater than 1 m. Shall be provided with plastic coated catch rings set in cement concrete vertically and staggered.

5.13.6 All manholes shall be provided with steel Fibre reinforced plastic (SFRC) covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Bill of Quantities or given above.

5.14 Cement concrete and masonry works (for manholes etc.)

5.14.1 Materials

a) Water

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Water used for all the constructional purposes shall be clear and free from oil, acid, alkali, organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for constructional purpose.

b) Aggregate for concrete
The aggregate for concrete shall be in accordance with I.S.383 and I.S. 515.in general; these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Architect/Construction Management Consultant/ Project Manager. The size of the coarse aggregate shall be done as per I.S.383.

c) Sand
Sand for various constructional purposes shall comply in all respects with I.S. 650 and I.S. 2116. It shall be clean, coarse hard and stone, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Architect/ Project Manager.

d) Cement
The cement used for all the constructional purposes shall be grade 43 or 53 conforming to I.S.269.

e) Mild steel reinforcement
The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I.S. 432 Grade I.

f) Bricks
Brick shall have uniform Colour, thoroughly burnt but not over burnt, shall have plain rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Architect/ Project Manager.

g) Other materials
Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Architect/ Project Manager.

5.14.2 Cement concrete (plain or reinforced)

a) Cement concrete pipes bedding, cradles, foundations and R.C.C. slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Architect/Construction Management Consultant/ Project Manager. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

b) Concrete work shall be of such thickness and mix as given in the Bill of Quantities.

c) All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

5.14.3 Masonry work
Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the bill of quantities in cement mortar 1:5 mix (1cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

5.14.4 Cement concrete for pipe support

a) Wherever specified or shown on the drawings, all pipes shall be supported in bed all round or haunches. The thickness and mix of the concrete shall be given in the Bill Of Quantities.

b) Unless otherwise directed by the Architect/Construction Management Consultant/ Project Manager cement concrete for bed, all around or in haunches shall be laid as follows :-

<table>
<thead>
<tr>
<th></th>
<th>upto 1.5 m depth</th>
<th>upto 3 m depth</th>
<th>beyond 3 m depth</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>Description</th>
<th>All round (1:3:6)</th>
<th>In Haunches (1:3:6)</th>
<th>In Haunches (1:3:6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoneware pipes buried in open ground (no sub soil water)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCC or SW in sub soil water</td>
<td>All round (1:3:6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC / HDPE pipe</td>
<td>All round (1:2:4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI Pipes (in all conditions)</td>
<td>All round (1:4:8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All pipes under building</td>
<td>All round (1:2:4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION – VI SPECIFICATIONS FOR WATER SUPPLY & DRAINAGE PUMPS

1. **Scope of work**

   Work under this section shall consists of furnishing all labour, materials, equiEngineer in chargeent and appliances necessary and required to supply install and commission the water supply and drainage pumps as described hereinafter and given in the schedule of quantities and/or shown on the drawings.

2. **General requirements**

   2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager/Owner rep.

   2.2 All equiEngineer in chargeent shall be of the best available as per approved make list manufactured by reputed firms.

   2.3 All equiEngineer in chargeent shall be installed on suitable foundations true to level and in a neat workmanlike manner.

   2.4 EquiEngineer in chargeent shall be so installed as to provide sufficient clearance between the end walls and between equiEngineer in chargeent to equiEngineer in chargeent.

   2.5 Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

   2.6 Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side along with pressure gauges as required.

   2.7 All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

3. **Pumping sets for Water Supply Pumps (Stainless Steel Pumps)**

   3.1 Water supply pumps shall be suitable for clean filtered water. Pumps shall be single stage, vertical/horizontal, centrifugal pumps with stainless steel body and stainless steel (DIN W-Nr .1.4301) impeller, stainless steel shaft and mechanical seal and coupled to a TEFC electric motor. Each pump should be operating to a curve required by the operating conditions.

   3.2 All parts in contract with water shall be corrosion resistant stainless steel DIN-Nr.1.4401.

   3.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 2900 RENGINEER IN CHARGE nominal speed.

   3.4 Each pumping set shall be provided with 100-mm dia gunmetal “Borden” type pressure gauge with gunmetal valve and connecting piping.

   3.5 Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Project Manager/Owner.

4. **Pumping sets for Garden Irrigation Pumps (Stainless Steel Pumps)**

   4.1 Water supply pumps shall be suitable for clean filtered water. Pumps shall be single stage, vertical/horizontal, centrifugal pumps with stainless steel body and stainless steel (DIN W-Nr .1.4301) impeller, stainless steel shaft and mechanical seal and coupled to a TEFC electric motor. Each pump should be operating to a curve required by the operating conditions.

   4.2 All parts in contract with water shall be corrosion resistant stainless steel DIN-Nr.1.4401.
4.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 2900 R ENGINEER IN CHARGE nominal speed.

4.4 Each pumping set shall be provided with 100-mm dia gunmetal “Borden” type pressure gauge with gunmetal valve and connecting piping.

4.5 Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Project Manager/Owner rep.

5. **Submersible pumps**

5.1. Submersible pumps for sewage/drainage shall be single stage, single entry pump. Pump shall be with C.I. casing and C.I. two vane open type dynamically balanced impeller connected to a common shaft to the motor. The vane for sewage pump will be open type, while for drainage pump etc. It will be of semi open type.

5.2 Stuffing box shall be provided with mechanical seals

5.3 Each pump shall be provided with water cooled squirrel cage induction motor suitable for 415 volts, 3 phase, 50 cycles AC power supply.

5.4 Each pump shall be provided with liquid level controller for operating the pump between predetermined levels. Operation of level controller shall be similar to as discussed in Para 6.1 & 6.2 below.

5.5 The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

5.6 Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

6. **Level Controllers**

6.1 Level controllers shall be electronic low voltage type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications:

6.2 Variable speed pumping system, filter feed pump and soft water transfer pump.

   To start/cut off all operating pumps when:

   a) Water level is low in storage water tanks with low water level audible alarm.

   b) To cut off filter feed pump and soft water transfer pump when water in tank is full.

6.3 Sump Pump level controller & high water alarm

   To cut off the drainage sump pump when the sump is empty and to start when:

   a) Duty pump No. 1 at pre-determined level No.1

   b) Duty pump No. 2 at a higher pre-determined level. No.2

7.0 **Pipe & Fittings (for Headers and Connections)**

7.1 Pump suction and delivery headers shall be Galvanized iron pipes/MS heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer’s instructions.

7.2 Vibration Eliminators
Provide on all suction and delivery lines as shown on the drawings double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

7.3 Valves

7.3.1 Butterfly Valves

Butterfly Valves shall be cast iron body with following details:

a) Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.

b) The shaft is EN-8 Carbon Steel with low friction nylon bearings.

c) The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.

d) Built in flanged rubber seals.

e) Actuator to level operated for valves above ground and T Key operated for valves below ground.

f) Built in flanges for screwed on flanged connections.

Manufacturer’s details on fixing and installation will be followed.

7.3.2 Non Return Valves (NRV)

a) Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.

b) NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform BS.

8. Painting and cleanup

a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.

b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.

c) Provide painted identification legend and direction arrows on all equipment in chargeent and piping as per directed by engineer-in-charge.

d) On final completion of the work, contractor should cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

8. Measurement

8.1 General

8.2 Unit rate for individual items, e.g., Pumps, MCC and level controller are for purposes of payments only. Piping, headers, valves, accessories, cabling and MCC to measured separately in this contract only.

8.3 All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

8.4 All water supply pumps

Pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.
8.5 Drainage Pumps

Drainage pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

8.6 Level controllers & Alarms

Level controllers for each set of pumps shall be measured by number and inclusive of probes, cabling unto surface box near the pump and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

8.7 Piping Work

8.7.1 Suction and delivery headers for each pumping system shall be measured per linear meter of finished length and shall include all items as given in the schedule of quantities. Painting shall be included in rate of headers.

8.7.2 G.I. pipes between various equipment shall be measured per linear meter of the finished length and shall include all fittings, flanges, jointing, clamps for fixing to walls or hangers and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.

8.7.3 Water Tank, Vibration eliminators, “Y” strainers, butterfly valves, slim non return valves shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications.
SECTION : VII - COMMISSIONING AND GUARANTEES

1 Scope of work

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2 General requirements:

2.1 The rates quoted in this tender shall be inclusive of the works given in this section.

2.2 Contractor shall provide all tools, metering and testing devices required for the purpose.

2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3 Pre-commissioning

3.1 On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices, the contractor shall proceed as follows:-

A water supply system:

i) Check all control valves and close if any valve is open. Also check all suction and delivery connections are properly made.

ii) Test run and check rotation of each motor and correct the same if required.

B Pipe work

i) Check all clamps, supports and hangers provided for the pipes.

ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

B. Handing over

1) All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorized representative.

2) Contractor shall also hand over, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

C. Guarantees

1) The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

2) The form of warranty shall be as approved by the Project Manager.

3) The warranty shall be valid for a period of one year from the date of commissioning and handing over.

4) The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

5) The warranty shall include replacement of any equipment found to have capacity lesser that the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Project Manager.
SECTION VIII: ELECTRICAL INSTALLATIONS

1 Scope
The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric control panels, wiring and Earthing of all air conditioning equiEngineer in chargeent, components and accessories, including supply, installation and wiring of remote control-cum-indicating light panel.

2 General
Work shall be carried out in accordance with the Specifications, Local Rules, Indian Electricity Act 1910 as amended up to date, and rules issued there under, Regulations of the Fire Insurance Company and relevant BIS Code of Practice.

3 Wiring System
All power wiring shall be carried out with 1100 volts grade PVC insulated, armored, overall PVC sheathed aluminum conductor cables for sizes above 6 sq mm. Sizes 6 sq mm and below the power wiring shall be of copper conductor only. Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using 650 volts PVC insulated copper conductor wires in race ways or in conduit. Minimum size of control wiring shall be 1.5 sq mm PVC insulated copper conductor wires. Minimum size of conductor for power wiring shall be 4 sq mm 1100 volts grade PVC insulated copper conductor wires in conduit.

4 Construction Features
The control panel shall be metal enclosed sheet steel cubicle, indoor type, dead front, floor mounting / wall mounting type. The control panel shall be totally enclosed, and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. Control panels shall be arranged in multi-tier formation. All doors and covers shall be suitable for double padlocking. All mild steel sheets used in the construction of control panels shall be 14 SWG thick for floor mounted and 16 SWG for wall mounting and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with Plumber metal.

All panels and covers shall be properly fitted and square with the frame and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel of 75 mm x 75 mm x 5 mm thick shall be provided at the bottom. Minimum clear space of 300 mm between the floor of control panel and bottom most unit (MCB or Bus Bar) shall be provided.

The control panels shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear. Knockout holes of appropriate size and number shall be provided in the control panels in conformity with the location of incoming and outgoing conduits/cables. All equiEngineer in chargeent such as meters and indicating lamps etc. shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from top of the control panel. Clamps shall be provided to support the weight of the cables. All power wiring inside the control panel shall be Colour coded and control wiring ferruled for easy identification. Circuit diagram showing the arrangement of circuits shall be pasted on the inside of panel door and covered with transparent plastic sheet and all labeling shall be provided in engraved anodized aluminium / bakelite strips on the front face of the panel board.

5 Circuit Compartment
Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the ‘ON’ position. Safety interlocks shall be provided to prevent the breaker or contactor from being drawn out when the breaker is in ‘ON’ position.

The door shall not form an integral part of the draw out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6 Instrument Accommodation
Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar.

7 **Bus Bars and Bus Bar Connections**

The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars, and half rated current for neutral bus bar and shall be extensible on either side. The bus bars and interconnections shall be insulated with PVC sleeve / tapes and shall be color coded. Alternatively special insulating paints / materials may be used for the purpose.

All bus bars shall be supported on unbreakable, Non hygroscopic insulated supports at regular intervals, to withstand the forces arising in case of short circuit in the system. All bus bars shall be provided in separate chamber and properly ventilated. All bus bars connections, in main control panels shall be done by drilling holes with cadmium plated / hot dipped galvanized bolts, nuts and washers.

All bus bars connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts.

All connections between the bus bar and breaker, and between breaker and contactor shall be through copper strips of proper size to carry rated current and shall be insulated with PVC sleeves.

8 **Raceways**

A horizontal race way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

9 **Cable compartments**

Cable compartment of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables.

10 **Indications**

1. `ON' lamps shall be provided on all outgoing feeders.

2. Cable alley and bus chamber shall be identified on all panels.

11 **Rubber Mat**

Rubber mat of ISI marked thickness not less than 12 mm shall be provided to cover the full length of front of all panels and rear of panels where back space shall be available for working from the rear.

12 **Materials**

All materials shall be of the best quality complying with the BIS (Bureau of Indian Standards) specifications. Materials used shall be subject to the approval of the Owner's site representative and samples of the same shall be furnished where required.

a. **Moulded Case Circuit Breaker**

MCCB shall comprise of switching mechanism, contact system, are extinguishing device and the tripping unit, Contained in a Compact, high strength, heat resistant, flame retardant, insulating Moulded case with high withstand capability against thermal and mechanical stress.

Switching mechanism shall be of Quick Make- Quick Break type and the trip command shall override all other commands. MCCB shall employ maintenance free contact system to minimize the let thru energies while handling abnormal currents.

The handle position shall give positive indication of `ON' `OFF' or tripped.

MCCB shall conform to IS- 2516 (Part I & II/Sec.1) 1985.
b. Miniature Circuit Breaker
Miniature circuit breakers shall be quick make and break type, and shall conform to Relevant Indian Standards. The housing shall be heat resistant and having high impact strength. The fault current shall not be less than 10 KA at 230 V and shall be BIS approved. MCBs shall be flush mounted and shall be provided with trip free manual operating lever and "ON" and "OFF" indications. The contacts shall be provided to quench the arc immediately. MCB shall be provided with magnetic thermal releases for over current and short circuit protection. The over load or short circuit device shall have a common trip bar in the case of D P, TP and TPN miniature circuit breakers.

c. Rotary Switches
Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism with stop as required. Rotary switches shall have HRC fuse fittings of appropriate rating.

d. Selector Switch
Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in charge in selective mode.

e. Starters
Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant BIS Codes. All Star Delta and ATS Starters shall be fully automatic. Starter’s contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta / Reduced Voltage Starters. The insulation for contactor coils shall be of class "B".

Operating coils of contactors shall be suitable for 230 / 415 +10% and (-) 15% volts AC, 50 cycles supply system. The contactors shall drop out when voltage drops to 90% of the rated voltage. The housing of the contactors shall be heat resistant and having high impact strength. Each starter shall have thermal overload protection on all three phases.

f. Over Load Relays
Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relays with adjustable setting. Hand-reset button shall be flush with the front door for resetting with starter compartment door closed. Relays shall be directly connected for motors upto 35 HP capacity. C.T operated relays shall be provided for motors above 35 HP capacities. Heater circuit contactors may not be provided with overload relays.

g. Current Transformers
Current transformers shall be of accuracy class I and suitable VA burden for operation of the connected meters and relays. These shall be resin bonded and epoxy coated.

h. Single Phase Preventor
Single phase preventor (current base) shall be provided as per Bill of Quantities and shall be in conformity with relevant BIS Standards. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

i. Time Delay Relays
Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connections.

j. Indicating Led (22 mm dia) and Metering
All meters and indicating lamps shall be in accordance with BS 37 and BS 39. The meters shall be flush mounted and draw out type. The indicating lamp shall be of LED type. Each main panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three Nos. CTs of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse. Other indicating lamps shall be backed up with fuses as called for.
k. Toggle Switch
Toggle switches, where called for, shall be in conformity with relevant BIS Codes and shall be of 5 amps rating.

l. Push Button Stations
Push button stations shall be provided for manual starting and stopping of motors/equipment as called for Green and Red Colour push buttons shall be provided for ‘Starting’ and ‘Stopping’ operations. ‘Start’ or ‘Stop’ indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for ‘Stop’ push buttons. The push button contacts shall be suitable for 6 amps current capacity.

m. Conduits
Conduits shall be of mild steel and shall be hard drawn, stove enameled inside and outside with minimum wall thickness of 1.6 mm for conduits upto 20 mm diameter and 2 mm wall thickness for conduits above 20 mm diameter. GI pull wires shall be installed in the conduit while laying the conduit.

n. Cables
M.V. cables shall be PVC insulated aluminium conductor and armored cables conforming to BIS Codes. Cables shall be armored and suitable for laying in trenches, duct, and on cable trays as required. M.V Cables shall be termite resistant. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armored cables.

o. Wires
1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

13 Cable Laying
Cable shall be laid generally in accordance with BIS Code of Practice. Cables shall be laid on 14 gauge perforated MS sheet cable trays, and cable drops / risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable with drawl / replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable. 1.1 KV cable shall be buried 600 mm below ground level.

14 Wire Sizes
For all single phase / 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminium conductor wires of adequate size. An isolator shall be provided near each motor / equipment in charge as wherever the motor/equipment in charge is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminium conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

The minimum size of control wiring shall be 1.5 Sq.m PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment in charge and control panels.

Power wiring cabling shall be of the following sizes:

Motor - Selection of cable and switchgear

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Starter Type</th>
<th>Full Load Current (Amp)</th>
<th>Al Cable 3 Core</th>
<th>Contactor Rating AC3 (Amp)</th>
<th>Overload Relay with SPP (Amps)</th>
<th>Earthing (2 nos.)</th>
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<td>(HP)</td>
<td>(KW)</td>
<td>Line Phas e Supply side Motor side</td>
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Page - 55
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</table>

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equiEngineer in chargeent body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

15 **Drawings**

Shop drawings for control panels and wiring of equiEngineer in chargeent showing the route of conduit/cable shall be submitted by the contractor for approval of Project Managers/ Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

16 **Testing**

Before commissioning of the equiEngineer in chargeent, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.
17 Painting

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

18 Labels and Tags

Engraved PVC labels shall be provided on all incoming and outgoing feeders’ switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at engineer in charge shall be provided with tags as approved by Project Managers.

19 All panels to have provision for padlocking and all MCCB’s/MCB’s to have provision for locking in off position.

20 Measurement of Electrical Control Panels

Panels shall be counted as number of units. Quoted rates shall include as lump sum (NOT measurable lengths) for all internal wiring, power wiring and Earthing connections from the control panel to the starter and to the motor, control wiring for inter-locking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate for panel shall also include all accessories, switchgear fuses, contactors, indicating meters and lights as per the specifications.
SECTION IX: SEWAGE TREATMENT PLANT

Design Parameters

1.0 Design Consideration

1.1 Capacity (Max): 300 M³/Day. STP based on MBBR Technology

1.2 Operation: Domestic Sewage (round the clock)

1.3 Incoming Influent

a. pH - 6.0 to 8.5
b. BOD 5 days @ 20 deg. C. - 250 to 350 mg/l
c. Suspended solids (SS) - 250 to 400 mg/l
d. Oil & grease - 50 to 100 mg/l
e. COD 5 - 450 to 600 mg/l

1.4 Effluent (Final) after filtration

a. pH - 6-8
b. BOD 5 days @ 20 deg. C. - Less than 20 Mg/L
c. Suspended solids (SS) - Less than 5 Mg/L
d. COD - Less than 80 Mg/L
e. Oil & grease (after grease trap) - Less than 5 Mg/L

2.0 Salient Features

2.1 The plant should be suitable for low/peak flow in line.

2.2 The plant should not create any noise, with no nuisance on fly or mosquito and no foul odors.

2.3 The plant should work without the use of in-organic chemical additives.

2.3.1 The plant should be provided with territory treatment in form of filters, chlorine dosing pumps and softener to provide zero bacteriological standard for reuse on:

a. Irrigation system.
b. Flushing System.
c. Cooling towers.

3. General

3.1 The plant should be eco friendly

3.2 Approval from local/pollution control board authority shall be obtained by the contractor.
TECHNICAL SPECIFICATIONS

1. **Basis of Design**

1.1 The capacity/rating of pumps and equiEngineer in charge etc. shall hold good for the capacity of 300 M³/Day and shall be good for meeting the treated parameters requirement as follows:

   g. Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically Engineered organizations or Cell Rules, 1989.
   h. Manual on sewage & sewage treatment - CPHEEO
   j. All standards as laid down by Central Pollution Control Board and any other relevant statutory authority.
   k. 100% recycle of waste water and removal of sludge in cake from, no water to be discharged outside the premises.

2.0 **Sewage Treatment Plant**

2.1 **General**

The sewage treatment plant (STP) system outlined in this section specifies the system design, manufacture, supply and installation of a standard MBBR based plant.

The work shall be carried out in a manner consistent with good practice in the local market.

A qualified and experienced Engineer shall be engaged for site supervision.

The Contractor shall submit analytical test reports of effluent water samples after the commissioning or after the system is put into operation or as required by the Engineer in charge:

First 3 months – 15 days

The report shall contain analysis of all data related to those requirements laid down by the local Authorities.

The effluent from the Sewage Treatment Plant shall be suitably treated and the effluent water recovered shall be used for irrigation purposes, flushing purpose and cooling tower etc.

2.2 **Description of Process**

The treatment process shall comprise the following stages:

- **Physical treatment:** Fine bar-screening
- **Primary treatment:** MBBR Tank
- **Equalization tank:** flow equalization with air Mixing
- **Treatment:** MBBR based
- **Tertiary treatment:** MGF, ACF, chlorination system & softener.
- **Water reclamation:** Tertiary filtration and sterilization (For irrigation, flushing & cooling tower purpose)
- **Sludge disposal:** Through Truck to community disposal area.
2.3 Performance Criteria of the Plant

Raw sewage will be brought into the Sewage Treatment Plant. The Contractor shall receive sewage from this point to the treatment plant for treatment process.

Treated effluent shall be connected to a tertiary filtration / treatment and shall be treated for use of irrigation purpose, flushing purpose & cooling tower purpose etc.

2.4 Process Description

2.4.1 Inlet Screen Chamber

Raw sewage from main sewer line shall flow into the inlet screen chamber by gravity. This manually cleaned screen is provided to remove floating and large size solids particles which may choke the pumps and the pipelines.

Equalization Tank

Screened sewage is then passed through equalization tank to homogenize the sewage quality and also even out flow fluctuations and feed sewage of uniform quality at constant rate to subsequent treatment units. Air mixing is also provided to mix the contents of the equalization tank. A coarse bubble aeration grid is provided to distribute air uniformly at the base of the equalization tank.

2.4.2 Sludge Thickening / Holding Tank

Excessive sludge shall be stored in the sludge holding tank for final dewatering and disposal.

3. EQUIENGINEER IN CHARGEENT

The following give the minimum requirements of the different components of the system.

All equiEngineer in chargeent and components of the system shall be of top quality construction and shall be corrosion resistant.

3.1 Fine Screening EquiEngineer in chargeent

Bar screen shall be of 304 stainless steel construction. Drip trays shall be provided for holding and drainage of the screenings. A manual by-pass screen of 30mm opening with stainless steel drip tray shall be provided. An isolation valve shall be provided to divert the flow to the by-pass screen when the screen requires service.

3.2 Air Blowers

Air blowers shall be provided with standby arrangement. Blowers shall be either of positive displacement or centrifugal with pressure vessel type complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be 1500 rEngineer in charge.

The size and performance of the air blower shall be so selected that it can provide a minimum air flow rate 0.5 1/sec / diffuser to 1l/sec/diffuser maximum, and to maintain a minimum of 2.0mg/l dissolved oxygen in the aeration tanks in operation.

3.3 Air Diffusers
Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system. The air diffuser shall be either made of elastomic rubber membrane or composed of crystalline fused aluminum oxide with a suitable ceramic bonding material.

Membrane endurance shall be more than 180,000 expansion/contraction cycles.

The Contractor shall submit calculation to justify the diffuser selection and air requirement during the detailed design.

3.4 Equalization Tank

The equalization tank shall be designed to provide a minimum storage of 2 hours at peak flow while pumping. Submersible pumps as per schedule shall be provided with level switch control and automatic cut-in of the standby unit.

An aeration system similar to the MBBR tank shall be provided for mixing and aerating the sewage.

3.5 Sewage Pumps

Working and standby sewage pumps shall be provided.

Each shall be of submersible type c/w guide base to facilitate case of removal, lift chain and automatic discharge connection.

3.6 Chlorination System

A chlorine feed system shall be furnished as a complete package assembly for installation in the plant room. Assembly shall include base plate, electronic positive displacement type chemical feed pump, fiber glass solution tank, suction and discharge tubing and fittings.

Each chlorine solution dosing pump shall perform to achieve a residue not more than 1 mg/l in the treated effluent. Solution feed pump shall have a maximum capacity of 6 l/hr. chemical pump will operate on 50 Hz supply. Fiber glass solution tank shall be of no less than 100 litres capacity and include suction line fitted with strainer.

3.7 Tertiary Treatment

This tertiary treatment shall be provided for the effluent used for irrigation, flushing & cooling tower purpose etc.

The tertiary treatment plant shall comprise of the MGF, ACF, UF & chlorine dosing system. This shall be sized to accommodate 100% of the effluent discharge flow rate and shall achieve the performance as outlined and described in Design Criteria.

3.8 Electrical Control

The operation of the treatment process shall be fully automatic.

A completely assembled and pre wired control panel consisting of weatherproof cabinet shall be furnished. The control panel shall contain all metering and status indicators, motor starters, program timers, on-off-auto change-over switches and duty selectors for equiEngineer in chargeent.

3.9 Other EquiEngineer in chargeent

Any other necessary accessories, such as buffer, riser, scrum removal devices, partition, control panel, collection devices, etc. for all the tanks and pumps (where necessary) shall be provided in order to provide a fully working systems.

3.10 Piping Materials

GI epoxy- Air piping and pumped effluent riser (Non submerged)
3.11 Valves

The Contractor shall supply and install all isolating valves and control valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.

All valves supplied shall be suitable for the working pressure and test pressure of the system as specified elsewhere in this specification.

All valves shall be full line size.

Furnish all valves and accessory materials necessary in the piping whether or not shown on drawings as flows.

Plastic or metal plates (rust less) shall be provided to indicate the open / close status as well as the use of each valve in the pump and tank rooms.

4. PIPE SUPPORTS

4.1 General Support

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

5. INSTALLATION

The Contractor shall check the associated civil work prior to the installation of any item of machinery and advise the Engineer in charge, in writing, of any deviation of such work from the specified details.

The machinery shall be accurately installed to correct dimensions, alignments, levels, etc., all as indicated on the final drawings. The machinery shall be mounted on flat steel packing pieces of thickness suitable to take up variations in level of the concrete foundations. Suitable packing pieces shall be located adjacent to each holding down bolt and shall be properly bedded by grinding the concrete surface to a smooth, level finish. The machinery shall be aligned and levelled and the nuts of the holding down bolts tightened with a spanner of normal length. The base plates shall be packed with grout after the machinery has been run and checked by the Engineer in charge for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

6. TESTING

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

7. COMMISSIONING

After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping’s, labors, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, wherever and as may be required. Generally, the following test/inspection has to be carried out:-
• For any Leakages/seepages in the external sewerage and drainage pipes.
• For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
• For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.
### SECTION – X : HANDING OVER PROCEDURE

#### DOCUMENTS SUBMISSION

The Contractor shall before finally handing over the completed work in his scope to the Owner, submit the documents as per the Contract and as directed by the Engineer-in-Charge. Given below the checklist for the reference of the Engineer-in-Charge.

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<th>Packages</th>
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A. Codes and reference standards referred to in the contract shall be understood to form a part of the contract.

B. Alternative reference standards produced by different standards authorities may be specified in a Section. Standards of any of the specified authorities may be acceptable, however, materials specified in the Section shall be incorporated in the works from only one of the specified standards authority to ensure compatibility in the performance of the materials.

C. The contractor shall be responsible for adherence to reference standard requirements by subcontractors and suppliers.

D. Where edition date is not specified, consider that reference to manufacturer's and published codes, standards and specifications are made to the latest edition (revision or amendment) approved by the issuing organization current at issue date of the Tender.

E. The specified reference standards are **INDIAN STANDARD CODES** and are intended to establish the quality of materials and workmanship required for the works. Reference standards published in other countries may, in the sole judgement of the owner's consultant, also be acceptable providing that the Contractor furnishes sufficient data for the Owner's Consultant to determine if the quality of materials and workmanship at least equals or exceeds all tests prescribed by the specified reference Indian Standards codes.

Such other reference standards published by the following will be considered:

- **BSI** : British Standards Institute
- **AFNOR** : Association Francise de Normalization (French Standards Institute)
- **DIN** : Deutsche Industries Norman (German Standards)
- **ANSI** : American National Standards Institute
- **ASTM** : American Society for Testing and Materials

F. Reference standards and specifications are quoted in the specification to establish minimum standards. Works of quality or of performance characteristics that exceed these minimum standards will be considered to confirm. Should regulatory requirements or the contract conflict with specified reference standards or specifications, the more stringent in each case shall govern.

G. Where reference is made to manufacturer's directions, instructions or specifications they shall include full information on storing, handling, preparing, mixing, installing, erection, applying or other matters concerning the materials pertinent to their use in the works and their relationship to materials with which they are incorporated.

H. Obtain copies of codes applying to the Work, manufacturer’s directions and reference standards referred to in the contract within 90 days of signing the contract.

I. Submit a copy of each code, reference standard and specification, and manufacturer's directions, instructions and specifications, to which reference is made in the specification to the Owner's Authorized Representative's.

J. **LIST OF CODES (INDIAN STANDARD CODES)**

Standards, specifications, associations, and regulatory bodies are generally referred to throughout the specifications by their abbreviated designations. The materials workmanship shall be in accordance with the requirement of the appropriate CP, I.S code wherever applicable together with any building regulations or bye-laws governing the works.

The following list is included for guidance only and the omission of any CP, I.S. codes from the list does not relieve the contractor from compliance therewith:

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:
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<td>PVC insulated cables for working voltages upto &amp; including 1100 V.</td>
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<td>Specification for water meters (domestic type).</td>
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<td>Specification for caulking load.</td>
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<td>800</td>
<td>Code of practice for general construction in steel</td>
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<td>Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.</td>
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<td>1172</td>
<td>Code of Basic requirements for water supply drainage and sanitation.</td>
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<td>1367 (Part 2)</td>
<td>Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.</td>
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<tr>
<td>1554 (Part 1)</td>
<td>PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V.</td>
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<tr>
<td>1554 (Part 2)</td>
<td>PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV.</td>
</tr>
<tr>
<td>1726</td>
<td>Specification for cast iron manhole covers and frames.</td>
</tr>
<tr>
<td>1742</td>
<td>Code of practice for building drainage.</td>
</tr>
<tr>
<td>2064</td>
<td>Selection, installation and maintenance of sanitary appliance code of practice.</td>
</tr>
<tr>
<td>2065</td>
<td>Code of practice for water supply in buildings.</td>
</tr>
<tr>
<td>2104</td>
<td>Specification for water meter for boxes (domestic type)</td>
</tr>
<tr>
<td>2373</td>
<td>Specification for eater meter (bulk type)</td>
</tr>
<tr>
<td>2379</td>
<td>Colour code for identification of pipe lines.</td>
</tr>
<tr>
<td>2629</td>
<td>Recommended practice for hot dip galvanizing on iron and Steel.</td>
</tr>
<tr>
<td>3114</td>
<td>Code of practice for laying of cast iron pipes</td>
</tr>
<tr>
<td>4127</td>
<td>Code of practice for laying glazed stoneware pipes.</td>
</tr>
<tr>
<td>4853</td>
<td>Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.</td>
</tr>
</tbody>
</table>
IS : 5329 Code of practice for sanitary pipe work above ground for buildings.
IS : 5455 Cast iron steps for manholes.
IS : 6159 Recommended practice for design and fabrication of material, prior to galvanizing.
IS : 7558 Code of practice for domestic hot water installations.
IS : 8321 Glossary of terms applicable to plumbing work.
IS : 8419 (Part 1) Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel.
IS : 8419 (Part 2) Requirements for water filtration equipment: Part 2 under drainage system.
IS : 9668 Code of practice for provision and maintenance of water supplies and fire fighting.
IS : 9842 Preformed fibrous pipe insulation.
IS : 9912 Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.
IS : 10221 Code of practice for coating and wrapping of underground mild steel pipelines.
IS : 10446 Glossary of terms relating to water supply and sanitation.
IS : 11149 Rubber Gaskets
IS : 5572 Code of practice for sanitary pipe work.
BS : 6700 Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.
BS : 8301 Code of practice for building drainage.
BSEN : 274 Sanitary tap were, waste fittings for basins, bidets and baths. General technical specifications.

2. **Pipes and Fittings**

IS : 458 Specification for precast concrete pipes (with and without reinforcement)
IS : 651 Salt glazed stone ware pipes and fittings.
IS : 1239 (Part 2) Mild Steel tubes, tubular and other wrought steel fittings: Part 2 Mild Steel tubular and other wrought steel pipe fittings.

IS : 1536 Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

IS : 1537 Vertically cast iron pressure pipes for water, gas and sewage.

IS : 1538 Cast Iron fittings for pressure pipes for water, gas and sewage.

IS : 1729 Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 1879 Malleable cast iron pipe fittings.

IS : 1978 Line pipe

IS : 1979 High test line pipe.

IS : 2501 Copper tubes for general engineering purposes

IS : 2643 (Part 1) Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions.

IS : 2643 (Part 2) Dimensions for pipe threads for fastening purposes: Part 2 Tolerances.

IS : 2643 (Part 3) Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.

IS : 3468 Pipe nuts.

IS : 3589 Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).

IS : 3989 Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 4346 Specifications for washers for use with fittings for water services.

IS : 4711 Methods for sampling steel pipes, tubes and fittings.

IS : 6392 Steel pipe flanges

IS : 6418 Cast iron and malleable cast iron flanges for general engineering purposes.

IS : 7181 Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

3. **Valves**

IS : 778 Specification for copper alloy gage, globe and check valves for water works purposes.

IS : 780 Specification for sluice valves for water works purposes (50 mm to 300 mm size).

IS : 1703 Specification copper alloy float valves (horizontal plunger type) for water supply fittings.

IS : 2906 Specification for sluice valves for water works purposes (350 mm to 1200 mm size)
<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 3950</td>
<td>Specification for surface boxes for sluice valves.</td>
</tr>
<tr>
<td>IS : 5312 (Part 1)</td>
<td>Specification for swing check type reflux (non return) valves: part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 5312 (Part 2)</td>
<td>Specification for swing check type reflux (non return) valves: part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 12992 (Part 1)</td>
<td>Safety relief valves, spring loaded: Design</td>
</tr>
<tr>
<td>IS : 13095</td>
<td>Butterfly valves for general purposes.</td>
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</tbody>
</table>

4. **Sanitary Fittings**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 771 (Part 1 to 3)</td>
<td>Specification for glazed fire clay sanitary appliances.</td>
</tr>
<tr>
<td>IS : 774</td>
<td>Specification for flushing cistern for water closets and urinals (other than plastic cistern)</td>
</tr>
<tr>
<td>IS : 775</td>
<td>Specification for cast iron brackets and supports for wash basins and sinks</td>
</tr>
<tr>
<td>IS : 781</td>
<td>Specification for cast copper alloy screw down bib taps and stops valves for water services.</td>
</tr>
<tr>
<td>IS : 1700</td>
<td>Specification for drinking fountains.</td>
</tr>
<tr>
<td>IS : 2556 (Part 4)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): part 4 specific requirements of wash basins.</td>
</tr>
<tr>
<td>IS : 2556 (Part 6 Sec 2)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): part 6 Specific requirements of urinals, section 2 half stall urinals.</td>
</tr>
<tr>
<td>IS : 2556 (Part 6 Sec 5)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals, section 5 waste fittings.</td>
</tr>
<tr>
<td>IS : 2556 (Part 6 Sec 6)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals, section 6 water spreaders for half stall urinals.</td>
</tr>
<tr>
<td>IS : 2556 (Part 7)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 7 Specific requirements of half round channels.</td>
</tr>
<tr>
<td>IS : 2556 (Part 8)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part 8 Specific requirements of siphoning wash down water closets.</td>
</tr>
<tr>
<td>IS : 2556 (Part 11)</td>
<td>Specification for vitreous sanitary appliances (vitreous china): Part</td>
</tr>
</tbody>
</table>
11 Specific requirements for shower rose.


IS : 2692  Specification for ferrule for water services

IS : 2717  Glossary of terms relating to vitreous enamelware and ceramic metal systems

IS : 2963  Specifications for waste plug and its accessories for sinks and wash basins.

IS : 3311  Specification for waste plug and its accessories for sinks and wash basins.

IS : 5961  Specification for cast iron gratings for drainage purposes.

IS : 6249  Specification for gel-coated glass fiber reinforced polyester resin bath tubs.

IS : 6411  Specification for gel-coated glass fiber reinforced polyester resin bath tubes.

IS : 8931  Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.

IS : 9758  Specification for flush valves and fitting for water closets and urinals.
FIRE FIGHTING SYSTEM

TECHNICAL SPECIFICATION

Work under this sub-head consists of furnishing all Labor, Materials, equipment and accessories necessary and required to completely install the Fire Fighting equipment etc., specified hereinafter and given in the

Without restricting to the generality of the foregoing the work of Fire Fighting System shall include the followings:

- Providing Mild Steel Black Pipe (IS: 1239 Part-1) (heavy Class C) pressure pipe line main including Valves, Fire Hydrants, Excavation for Pipe, Laying of pipe, Painting of pipe and Making Connection to supply system.
- Black Steel Pipe, Mains Laterals, Branches, Valves, Hangers and Appurtenances.
- Portable Fire Extinguishers
- Testing Commissioning and giving live demonstrations to the various Inspection Authorities and Obtain their "No Objection Certificate" (NOC) for occupation of the building.

Fire Hydrant System

1.1 Scope of work

1.1.1 Wet riser fire hydrant system (internal & external )

1.1.2 Valves, suction and delivery connections and headers.

1.1.3 Pipe protection, painting, sleeves & minor civil works other than specifically mentioned in the tender.

1.1.4 Specialized protection as specified.

1.1.5 Testing and commissioning.

1.2. General Requirements

1.2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Managers.

1.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

1.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

1.2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

1.2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

1.3 Pipes

1.3.1 All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be GI Pipes as follows:

- Pipes 150 mm dia and below IS: 1239 or BS: 1387 Heavy Class
- Pipe 200 mm dia and above IS 3589 of thickness specified.

1.4 Pipe Fittings.
1.4.1 Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are need to complete the piping work in its totality.

1.4.2 Fabricated fittings shall be not be permitted for pipe diameters 50 mm and below.

1.5 Jointing

1.5.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed GI forged fittings).

1.5.2 Welded (65 mm dia and above)

Joints between GI and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt-welded joints are not acceptable. Buried pipes will be subject to x ray test from an approved agency at the cost of contractor. (With welded M.S. fittings heavy class with “V” groove).

1.5.3 Flanges

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.

c) Flanges shall be as per I.S: 6392-1971 Table 17/18 with appropriate number of half thread nuts bolts and make GKW, 3 mm insertion neoprene gasket complete.

1.5.4 Unions

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

1.6 Excavation

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.

On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

Contractor shall dispose off all surplus earth with in a lead of 200m or as directed by Project Manager.

1.7 Anchor Thrust Blocks

a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.
1.8 Valves

1.8.1 Ball Valves

- Valves 50 mm dia & below shall be heavy type nickel plated Brass body screwed type with chromium plated brass balls, PTFE Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq cm including coupling and gunmetal handle conforming to B.S. 5351 with female screwed ends.

- All valves shall be approved by the Project Manager before they are allowed to be used on work.

1.8.2 Butterfly Valves

Butterfly Valves shall be cast iron body and shall be of class P.N 16 tested to 20 kg/cm² with following details:

- Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.

- The shaft is EN-8 Carbon Steel with low friction nylon bearings.

- The seat shall be drop tight constructed by bonding resilient electrometer inside a rigid backing.

- Built in flanged rubber seals.

- Actuator to level operated for valves above ground and T Key operated for valves below ground.

- Built in flanges for screwed on flanged connections.

Manufacturer’s details on fixing and installation will be followed.

1.8.3 Non Return Valves (NRV) dual plate type non return valves PN 16

- Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.

- Non-return valves shall be wafer type check valve with cast iron body and disk, S. Steel pin and hinges, nitrite/neoprene seal, suitable for horizontal/vertical line installation conforming to IS: 5312.

1.8.4 Air vessel / Air Cushion tank.

- Air cushion tank shall be of size and capacity indicated in schedule of quantities. It shall be provided at the top most point/points and/or in pump house (as specified). The tank shall be complete 25 mm dia. Brass Air Valve (Ball type), Stop Valve (25mm dia), Drain valve (25mm dia) and pressure gauge including 25mm dia. Mild Steel M.S. pipes and fittings, unions, etc. as required to complete the work as per site conditions.

1.8.5 Air Cushion tank shall be measured by numbers and shall include Air Valve, Pressure Gauge, and Globe Valves for testing and draining, M.S. Clamps, Pipes, Fittings, Tees Elbows Union and all other items required completing the work.

1.8.6 Orifice Flanges

- Provide orifice flanges fabricated from 6 mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm² and allow a discharge of 560 lEngineer in charge.

1.8.7 Drain Valve

- Provide 25 mm dia black steel pipe to IS: 1239 (heavy class) with 25 mm Ball valve for draining any water in the system in low pockets.

1.8.8 Inspection & testing assembly
Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of
gunmetal valves, gunmetal sight glass, bye-pass valve. The drain pipe beyond the valve up to the drainage
point shall be measured with the pipe.

1.8.9. Pump test assembly

Provide on the main fire sprinkler header a 150 mm dia bye-pass valve located in an accessible manner
along with a rate of flow rotometer calibrated in l/Engineer in charge and able to read 200% of the rated
pump capacity. The delivery shall be connected to the fire tank.

1.8.10 Pressure Gauge

Pressure gauge shall be provided at pump room area and terrace hydrants only. Pressure gauge shall be 100
mm dia gunmetal Bourden type with gunmetal isolation cock, tapping and connecting pipe and nipple. The
gauge shall be installed at appropriate level and height for easy readability.

2. Hydrant/valve chambers

2.1 Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand)
on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone
aggregate 40 mm nominal size) 15 mm thick cement plaster inside and outside finished with a
floating coat of neat cement inside with cast iron surface box approved by fire brigade including
excavation, back filling complete.

2.2 Valve chambers shall be 120 x 120 cms. For depths up to 100 cms.

3. Fire brigade connections

Provide as shown on drawings separate gunmetal 4 way collecting head with four 63 mm instantaneous
type inlets with built in check valves and 150 mm dia outlet connected to the fire and sprinkler main.
Collecting head shall be installed on a stand post and provided with horizontal C.I. reflux valve and
location to be approved by Project Manager. Provide etched gunmetal label plates with 50mm height letter.
The plates should be firmly fixed to the FB connection and any support system.

4. Fire hydrants

4.1 External hydrants

a) Contractor shall provide external hydrants. The hydrants shall be single headed gun metal landing
valve with instantaneous type 63 mm dia outlet, controlled by a cast iron butterfly valve installed in
underground lockable chambers. The hydrants shall be conforming to I.S. 5290 with bend, M.S.
flanged riser of required height to bring the hydrant to correct level above ground.

b) Contractor shall provide for each external fire hydrant station two numbers of 63 mm dia. 15 m long
non percolating rubberized fabric lined hose pipes to I.S. 636 Type A with SS male and female
instantaneous type coupling to I.S. 903 riveted and bound with 1.5 mm copper wire to hose pipe, fire
hose reel, SS branch pipe with nozzle I.S. 903.

4.2 Internal hydrants

a) Contractor shall provide on each landing and other locations as shown on the drawings one single
headed SS landing valve with 63 mm dia outlet mounted on a common 80 mm inlet (I.S.5290-1969). Llanding valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b) Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for fire
brigade hoses.

c) Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long
non percolating rubberized fabric lined hose pipes to I.S. 636 Type A with SS male and female
instantaneous type coupling to I.S. 903 riveted and bound with 1.5 mm copper wire to hose pipe, fire
hose reel, SS branch pipe with nozzle I.S. 903.
d) Each hose box shall be conspicuously painted with the letters "FIRE HOSE".

e) 4.3 Fire hose reels

Contractor shall provide standard fire hose reels with 20 mm dia high pressure thermoplastic hose 36.5 m long with SS nozzle and control valve, shut off valve, all mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall be connected directly to the wet riser. Hose reel shall conform to IS: 884-1969 and rubber hose to IS: 5132.

4.4 Hose Cabinets

a. Provide hose cabinets for all internal fire hydrants. Hose cabinets shall be fabricated from 16 gauge M.S. sheet of fully welded construction with hinged double front door partially glazed with locking arrangement, stove enameled fire red paint with "FIRE HOSE" written on it prominently. (Size as given in the Bill of Quantities).

4.5 Pipe protection

a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPCOTE or equivalent multi-layer sheet as per standard manufacturer's specifications.

4.6 Pipe Supports

a) All pipe clamps and supports shall be galvanized steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

b) Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally accounted.

4.7 Pipe Spacing Table

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Pipes &amp; Position</th>
<th>15/20</th>
<th>20/25</th>
<th>32/40</th>
<th>50</th>
<th>75/80</th>
<th>100/110</th>
<th>150/160</th>
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<tbody>
<tr>
<td>1</td>
<td>Vertical</td>
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</tr>
<tr>
<td>1.1</td>
<td>GI /MS</td>
<td>2.4</td>
<td>2.4</td>
<td>3</td>
<td>3.6</td>
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<td>CI Heavy Duty IS 1536</td>
<td>X</td>
<td>x</td>
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<td></td>
<td></td>
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<td>2.0</td>
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<td>uPVC Water Supply</td>
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</tbody>
</table>
4.8 Testing

a. All piping in the system shall be tested to a hydrostatic pressure of 1.5 times the working pressure or 20 kg/sq.cm (whichever is more) without drop in pressure for at-least 2 hours.

b. Rectify all leakages, make adjustments and retest as required and directed.

4.9 Cables

a. Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

b. All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 volt grade.

c. All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

d. All cable joints shall be made in an approved manner as per standard practice.

Cable Trays

i. All cables shall be routed in approved locations in coordination with all other services in a proper manner.

ii. Cable trays shall be of galvanized steel and hung from the ceiling by galvanized rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

Fire Sprinkler System

1 Scope of work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment in charge and appliances including scaffolding, M.S. ladders etc. necessary and required to completely install wet riser fire hydrant and sprinkler system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the work shall include but not limited to the following:-

a) Piping for Sprinkler systems.

b) Sprinkler heads, spare sprinklers

c) Inspection & test assemblies and accessories

2 General

2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.
3 Pipes

a) All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be GI. pipes as follows:

b) Pipes 150 mm dia and below IS: 1239/ BS: 1387 Heavy Class

4 Pipe Fittings

a) Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. and all such connecting devices that are need to complete the piping work in its totality.

b) Screwed fittings shall be approved type malleable or cast iron fittings suitable for screwed joints.

c) Forged steel fittings of approved type with "V" groove for welded joints.

d) Fabricated fittings shall be not being permitted for pipe diameters 50 mm and below.

5 Jointing

5.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

5.2 Welded (65 mm dia and above)

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints are not acceptable.

5.3 Flanged

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger Diameter.

c) For jointing all types of valves, appurtenances, pumps, connections with other Type of pipes, to water tanks and other places necessary and required as Good for engineering practice.

d) Flanges shall be as per I.S. with appropriate number of G.I. nuts and bolts, 3 mm Insertion neoprene gasket complete.

5.4 Unions

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

6 Excavation

6.1 Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

6.2 Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.
6.3 On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

6.4 Contractor shall dispose of all surplus earth within a lead of 200 m or as directed by Project Manager.

7 Anchor Thrust Blocks

a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

8 Valves

8.1 Cast Iron Butterfly Valves

8.1.1 Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

8.1.2 Butterfly valves shall be of best quality conforming to I.S.13095 of class specified.

8.3 Non-return valves (Check Valves)

Non-return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

8.4 Air valves

Provide 25 mm dia screwed inlet cast iron single acting air valve, on all high points in the system or as shown on drawings.

8.5 Orifice Flanges

Provide orifice flanges fabricated from 6 mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm² and allow a discharge of 560 l/Engineer in charge. The contractor shall submit design of the orifice flanges for approval before installation.

8.6 Drain Valve

Provide 50 mm dia black steel pipe to IS: 1239 (heavy class) with 50 mm gunmetal fullway valve for draining any water in the system in low pockets.

8.7 Inspection & testing assembly

Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, and bye-pass valve. The drain pipe beyond the valve upto the drainage point shall be measured with the pipe.

9. Pipe protection

a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPcoat multilayer sheet as per standard manufacturer's specifications.

10. Pipe Supports
10.1 All pipe clamps and supports shall be galvanized steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

10.2 Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

11 Sprinkler Heads

11.1 Sprinkler heads shall be quartzoid bulb type with gunmetal body fully approved and having current certification of the fire laboratory of the C.B.R.I. Roorkee, Underwriter's laboratory (UL) and under the approved certified list of the Fire Office Committee (FOC) of U.K. or NFPA of USA. Any one of the certification as acceptable to the local fire authorities obtained prior to the procurement and approved and accepted by the Project Manager.

11.2 Sprinkler heads shall be installed in conformity with approved shop drawings and in co-ordination with electrical fixtures, ventilation ducts, cable galleries and other services along the ceiling.

11.3 Following type of sprinklers shall be used:

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<tr>
<th>S.No.</th>
<th>Type of Sprinkler</th>
<th>Temp rating °C</th>
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<tbody>
<tr>
<td>1.</td>
<td>Pendant or upright</td>
<td>68</td>
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<tr>
<td>2.</td>
<td>Special application quick wall Type with throw suitable for Room size of 5 m length (Extended type)</td>
<td>68</td>
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<tr>
<td>3.</td>
<td>Semi concealed type (Recessed in rosette)</td>
<td>68</td>
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</tbody>
</table>

11.4 Spacing and coverage of sprinkler shall be in accordance with risk classification of area in which they are installed, design density and TAC regulation.

12 Spare Sprinklers

a) Provide lockable enamel painted steel cabinet including following type of spare sprinklers

i) Semi concealed type, Pendant or Upright type.

b) The cabinet should also contain one pair of wrenches (of each size of the same are different) for the sprinklers.

c) Spare sprinklers shall be of the same specifications as that of the original sprinklers specified.

13 Testing

13.1 All piping in the system shall be tested to a hydrostatic pressure of 14 kg/cm² without drop in pressure for at least 8 hours.

13.2 Rectify all leakages, make adjustments and retest as required and directed.

Fire Pumps & Ancillary Equipment in charge

1 Scope of Work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment in charge and
appliances necessary and required to completely install electrically operated and diesel driven pumps as required by the drawings and specified hereinafter or given in the schedule of quantities.

1.2 Without restricting to the generality of the foregoing, the pumps and ancillary equipment in charge shall include the following:

a) Electrically operated and diesel driven pumps with motors, base plates and accessories.

b) Alarm system with all accessories wiring and connections

c) Pressure gauges with isolation valves & piping bleed and block valves.

d) M.S. pipes, valves, suction strainers, delivery headers & accessories.

e) Foundations, vibration eliminator pads and foundation bolts.

2 General Requirements

i) Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.

ii) Pumps and motors shall be truly aligned by suitable instruments.

iii) All pump connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.

iv) Manufacturer’s instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.

a) Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The Contractor shall provide facilities to the Project Manager or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer’s works without any cost to the owners.

b) Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.

c) Provide vibration eliminating pad and connectors for each pump.

d) The Contractor shall submit with this tender a list of recommended spare parts for two years of normal operation and quote the prices for the same.

3 Fire, Sprinkler & Jockey Pumps

3.1 Pumping Sets

a) Pumping sets shall be single stage single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be of stainless steel with bronze sleeve and grease lubricated bearings.

b) Pumps shall be connected to the drive by means of spacer type love joy couplings which shall be individually balanced dynamically and statically.

c) The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.

3.2 Pumps shall be provided with approved type of mechanical seals.

3.3 Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.

3.4 The pump shall meet the requirements of the Tariff Advisory Committee and the unit shall be design proven in fire protection services.

4 Electric drive
4.1 Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.

4.2 Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

4.3 Motors shall be wound for class B insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.

4.4 Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee.

4.5 Motors shall be suitable for 415±10% volts, 3 phase 50 cycles a/c supply and shall be designed for 38 deg C ambient temperature. Motors shall conform to I.S. 325.

4.6 Motors shall be designed for two start system.

4.7 Motors shall be capable of handling the required starting torque of the pumps.

4.8 Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.

4.9 Speed of the motor shall be compatible with the speed of the pump.

5 Diesel Engine

5.1 Diesel engine shall be of 6 cylinders with individual head assemblies. The engine shall be water cooled and shall include heat exchanger and connecting piping, strainer, isolating & pressure reducing valves, bye-pass line complete in all respects.

5.2 Engine shall be direct injection type with low noise and exhaust emission levels.

5.3 The speed of the engine shall match the pump speed for direct drive.

5.4 The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg C and shall take full load within 15 seconds from the receipt of the signal to start.

5.5 The engine shall efficiently operate at 38 deg.C ambient temperature at 50 meters above mean sea level.

5.6 Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 meters distance.

5.7 The engine shall be self-starting type upto 4 deg C and shall be provided with one 24 volts heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.

5.8 A battery re-charger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator shall be provided.

5.9 The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.

5.10 Engine shall be suitable for running on high speed diesel oil.

5.11 The system shall be provided with a control panel with push button starting arrangement also and wired to the engine on a differential pressure gauge.

5.12 The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.

5.13 One self supported one day oil tank fabricated from 5 mm thick MS sheet electrically welded with a capacity of 8 hours working load but not less than 200 lit shall be provided. Level indicating gauge glass on the day oil tank and low fuel level indication on the control panel shall also be provided.
5.14 One exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions shall be provided.

5.15 All other accessories fittings & fixtures necessary and required for a complete operating engine set shall be provided.

5.16 Contractor shall indicate special requirements, if any, for the ventilation of the pump room.

5.17 The materials of construction for the major components are as follows:

- **Casting**: Cast iron
- **Impeller**: Bronze
- **Shaft**: EN-8
- **Wear Rings**: Bronze
- **Gland Packing**: Graphite Asbestoc
- **Type of Bearing**: Ball bearing/Roll Bearing
- **Type of coupling**: Flexible couplings

5.18 **Instrumentation**

The diesel engine shall be provided with the following instrumentation:

a) Temperature indicator in cooling water inlet and outlet
b) Temperature indicator in lubricating oil outlet from the oil cooler
c) Pressure gauge for lubricating oil system
d) Speed indicator
e) Lubricating oil sump level indicator
f) Fuel oil tank level indicator
g) Voltmeter and ammeter in battery charging circuit
h) Cooling water high temperature alarm
i) Oil pressure low alarm

A local instrument panel shall be provided with the engine for mounting all the above instruments and annunciation.

5.19 Pumps and motor engine shall be mounted on a common base frames fabricated from M.S. structural and placed in suitable concrete foundations with the help of approved cushy foot mountings (Anti-vibration pads) to avoid vibrations. The anti-vibration pads shall be of heavy duty type.

6 **Air Vessel**

6.1 Provide one air vessel fabricated from 10 mm M.S. plate with dished ends 8 mm thick shell and suitable supporting legs. Air vessel shall be provided with a 50 mm dia connection from pump, one 25 mm dia drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 250 mm dia x 1000 mm high and tested to 20 kg/sq cm pressure.

6.2 The fire pumps shall operate on drop of pressure in the mains as given in Para 3.6.3 below. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

6.3 Operating conditions for fire pumps.
a) Operating pressure
   Cut in: 8.0 Kg/sq cm
   Cut out: 

b) Jockey pump
   Cut in: 7.0 kg/sq cm
   Cut out: 8.0 kg/Sq.Cm

c) Fire Electric Pump Hydrant
   Cut in: 6.0 Kg/sq cm
   Cut out: Manual

d) Diesel Engine Driven Pump
   Cut in: 4.5 kg/sq cm
   Cut out: Manual

Notes:

a) Jockey pump shall start and stop through pressure switch automatically.

b) Jockey pump shall stop when main pump starts.

Main pumps shall start automatically on fall of pressure but stopping shall be manual.

7 Vibration Eliminators

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufactures details.

GUARANTEE

The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

The warranty shall be valid for a period of Three year from the date of commissioning and handing over.

The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-Charge.

1 General

1.1 The work shall be executed as per CPWD’s general specification for Electrical Works Part-I (Internal)-2013, Part-II(External)-1995, Part-IV(Sub-Station )-2007, Part-V (Wet Riser and Sprinkler System for Fire Fighting Installations)-2006,IE Rules, Indian Standards amended upto date and as per direction of Engineer-in-Charge. The additional specifications/ conditions are to be read in these additional conditions shall apply. However nothing extra shall be paid on account of these additional specification and conditions, as the same are to be read along with schedule of quantities for the work and in case of any variations, specifications given along with the tender shall apply.

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## Material Of Construction

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IMPORTANT INSTRUCTION FOR QUALITY OF WATER

The successful contractor will have to carry out a test of raw water from all the sources of water for the Commercial, Residential & apartment at their own cost from a reputed lab as approved by the Engineer-in-Charge / Consultant. On the basis of these results the contractor has to submit his shop drawings, design calculations and specifications accordingly.

Please note that it is ultimately the responsibility of the contractor to provide treated water for different use as per International Standard as given in the attached guidelines.

REQUIRED QUALITY OF TREATED WATER
SECTION XII: I.S. CODES AND REFERENCE STANDARDS.

A. Codes and reference standards referred to in the contract shall be understood to form a part of the contract.

B. Alternative reference standards produced by different standards authorities may be specified in a Section. Standards of any of the specified authorities may be acceptable, however, materials specified in the Section shall be incorporated in the works from only one of the specified standards authority to ensure compatibility in the performance of the materials.

C. The contractor shall be responsible for adherence to reference standard requirements by subcontractors and suppliers.

---

**BIS 10 5000 standards for drinking water**

**Essential characteristics**

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<th>Requirement, desirable</th>
<th>Permissible limit in the absence of an alternative source</th>
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<td>Taste</td>
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**Desirable characteristics**

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<td>Mercury as Hg, mg/l, max</td>
<td>0.001</td>
<td>No relaxation</td>
</tr>
<tr>
<td>19</td>
<td>Cadmium as Cd, mg/litr, max</td>
<td>0.01</td>
<td>No relaxation</td>
</tr>
<tr>
<td>20</td>
<td>Selenium as Se, mg/litr, max</td>
<td>0.01</td>
<td>No relaxation</td>
</tr>
<tr>
<td>21</td>
<td>Arsenic as As, mg/litr, max</td>
<td>0.01</td>
<td>No relaxation</td>
</tr>
<tr>
<td>22</td>
<td>Cyanide as CN, mg/litr, max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td>23</td>
<td>Lead as Pb, mg/litr, max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td>24</td>
<td>Zinc as Zn, mg/litr, max</td>
<td>5.0</td>
<td>No relaxation</td>
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<tr>
<td>25</td>
<td>Anionic detergents, mg/litr, max</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>26</td>
<td>Chromium as Cr, mg/litr, max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td>27</td>
<td>Polynuclear Hydro carbons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Mineral oil, mg/litr, max</td>
<td>0.01</td>
<td>0.03</td>
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<tr>
<td>29</td>
<td>Pesticides mg/litr, max</td>
<td>Absent</td>
<td>0.001</td>
</tr>
<tr>
<td>30</td>
<td>Alkalinity, mg/litr, max</td>
<td>210</td>
<td>600</td>
</tr>
<tr>
<td>31</td>
<td>Aluminium as Al, mg/litr, max</td>
<td>0.03</td>
<td>0.2</td>
</tr>
<tr>
<td>32</td>
<td>Boron as B, mg/litr, max</td>
<td>1.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>
D. Where edition date is not specified, consider that reference to manufacturer's and published codes, standards and specifications are made to the latest edition (revision or amendment) approved by the issuing organization current at issue date of the Tender.

E. The specified reference standards are **INDIAN STANDARD CODES** and are intended to establish the quality of materials and workmanship required for the works. Reference standards published in other countries may, in the sole judgement of the owner's consultant, also be acceptable providing that the Contractor furnishes sufficient data for the Owner's Consultant to determine if the quality of materials and workmanship at least equals or exceeds all tests prescribed by the specified reference Indian Standards codes.

Such other reference standards published by the following will be considered:

- **BSI**: British Standards Institute
- **AFNOR**: Association Francaise de Normalization (French Standards Institute)
- **DIN**: Deutsche Industries Norman (German Standards)
- **ANSI**: American National Standards Institute
- **ASTM**: American Society for Testing and Materials

F. Reference standards and specifications are quoted in the specification to establish minimum standards. Works of quality or of performance characteristics that exceed these minimum standards will be considered to confirm.

Should regulatory requirements or the contract conflict with specified reference standards or specifications, the more stringent in each case shall govern.

G. Where reference is made to manufacturer's directions, instructions or specifications they shall include full information on storing, handling, preparing, mixing, installing, erection, applying or other matters concerning the materials pertinent to their use in the works and their relationship to materials with which they are incorporated.

H. Obtain copies of codes applying to the Work, manufacturer’s directions and reference standards referred to in the contract within 90 days of signing the contract.

I. Submit a copy of each code, reference standard and specification, and manufacturer's directions, instructions and specifications, to which reference is made in the specification to the Owner's Authorized Representative's.

J. **LIST OF CODES (INDIAN STANDARD CODES)**

Standards, specifications, associations, and regulatory bodies are generally referred to throughout the specifications by their abbreviated designations. The materials workmanship shall be in accordance with the requirement of the appropriate CP, I.S code wherever applicable together with any building regulations or bye-laws governing the works.

The following list is included for guidance only and the omission of any CP, I.S. codes from the list does not relieve the contractor from compliance therewith:

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:

- **SP : 6 (1)** Structural Steel Sections
- **IS : 27** Pig Lead
- **IS : 325** Three Phase Induction Motors
- **IS : 554** Dimensions for pipe threads where pressure tight joints are required on the threads.
- **IS : 694** PVC insulated cables for working voltages upto & including 1100 V.
- **IS : 779** Specification for water meters (domestic type).
| IS : 782  | Specification for caulking load.                          |
| IS : 800  | Code of practice for general construction in steel       |
| IS : 1068 | Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium. |
| IS : 1172 | Code of Basic requirements for water supply drainage and sanitation. |
| IS : 1367 (Part 2) | Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances. |
| IS : 1554 (Part 1) | PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V. |
| IS : 1554 (Part 2) | PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV. |
| IS : 1726  | Specification for cast iron manhole covers and frames.   |
| IS : 2064  | Selection, installation and maintenance of sanitary appliance code of practice. |
| IS : 2065  | Code of practice for water supply in buildings.           |
| IS : 2104  | Specification for water meter for boxes (domestic type)  |
| IS : 2373  | Specification for water meter (bulk type)                |
| IS : 2379  | Colour code for identification of pipe lines.            |
| IS : 2629  | Recommended practice for hot dip galvanizing on iron and Steel. |
| IS : 3114  | Code of practice for laying of cast iron pipes           |
| IS : 4853  | Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes. |
| IS : 5329  | Code of practice for sanitary pipe work above ground for buildings. |
| IS : 5455  | Cast iron steps for manholes.                            |
| IS : 6159  | Recommended practice for design and fabrication of material, prior to galvanizing. |
| IS : 7558  | Code of practice for domestic hot water installations.    |
| IS : 8321  | Glossary of terms applicable to plumbing work.            |
| IS : 8419 (Part 1) | Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel. |
| IS : 8419 (Part 2) | Requirements for water filtration equipment: Part 2 under drainage |
system.

IS : 9668  Code of practice for provision and maintenance of water supplies and fire fighting.

IS : 9842  Preformed fibrous pipe insulation.

IS : 9912  Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.

IS : 10221  Code of practice for coating and wrapping of underground mild steel pipelines.

IS : 10446  Glossary of terms relating to water supply and sanitation.

IS : 11149  Rubber Gaskets


IS : 5572  Code of practice for sanitary pipe work.

BS : 6700  Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.

BS : 8301  Code of practice for building drainage.

BSEN : 274  Sanitary tap ware, waste fittings for basins, bidets and baths. General technical specifications.

2. Pipes and Fittings

IS : 458  Specification for precast concrete pipes (with and without reinforcement)

IS : 651  Salt glazed stone ware pipes and fittings.


IS : 1239 (Part 2) Mild Steel tubes, tubular and other wrought steel fittings: Part 2 Mild Steel tubular and other wrought steel pipe fittings.

IS : 1536  Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

IS : 1537  Vertically cast iron pressure pipes for water, gas and sewage.

IS : 1538  Cast Iron fittings for pressure pipes for water, gas and sewage.

IS : 1729  Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 1879  Malleable cast iron pipe fittings.

IS : 1978  Line pipe

IS : 1979  High test line pipe.
IS : 2501  Copper tubes for general engineering purposes
IS : 2643 (Part 1)  Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions.
IS : 2643 (Part 2)  Dimensions for pipe threads for fastening purposes: Part 2 Tolerances.
IS : 2643 (Part 3)  Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.
IS : 3468  Pipe nuts.
IS : 3589  Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS : 3989  Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4346  Specifications for washers for use with fittings for water services.
IS : 4711  Methods for sampling steel pipes, tubes and fittings.
IS : 6392  Steel pipe flanges
IS : 6418  Cast iron and malleable cast iron flanges for general engineering purposes.
IS : 7181  Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

3. **Valves**
   IS : 778  Specification for copper alloy gage, globe and check valves for water works purposes.
   IS : 780  Specification for sluice valves for water works purposes (50 mm to 300 mm size).
   IS : 1703  Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
   IS : 2906  Specification for sluice valves for water works purposes (350 mm to 1200 mm size)
   IS : 3950  Specification for surface boxes for sluice valves.
   IS : 5312 (Part 1)  Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
   IS : 5312 (Part 2)  Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
   IS : 12992 (Part 1)  Safety relief valves, spring loaded : Design
   IS : 13095  Butterfly valves for general purposes.

4. **Pumps & Vessels**
   IS : 1520  Specification for horizontal centrifugal pumps for clear cold fresh water.
IS : 2002  Steel plates for pressure vessels for intermediate and high temperature service including boilers.

IS : 2825  Code for unfired pressure vessels.


IS : 5600  Specification for sewage and drainage pumps

IS : 8034  Specification for submersible pump sets for clear, cold, fresh water.

IS : 8418  Specification for horizontal centrifugal self priming pumps.

5  **Fire Fighting Equipment**

SP:7  Amendment No. III to NBC Part-IV Fire Protection Jan 1997

TAC  Tariff Advisory Committee fire protection manual Part-I.

TAC  Rules of Tariff Advisory Committee for automatic sprinkler system.

NFPA : 12 , 1993  Standards on Carbon Dioxide Extinguishing System

IS : 636  Non-percolating flexible fire fighting delivery hose.

IS : 884  Specification for first aid hose reel for fire fighting.

IS : 901  Specification for couplings, double male and double female, instantaneous pattern for fire fighting.

IS : 902  Suction hose couplings for fire fighting purposes.

IS : 903  Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner.

IS : 904  Specification for 2-way and 3-way suction collecting heads for fire fighting purposes.

IS : 907  Specification for suction strainers, cylindrical type for fire fighting purposes.

IS : 908  Specification for fire hydrant, stand post type.

IS : 909  Specification for underground fire hydrant, sluice valve type.

IS : 910  Specification for portable chemical foam fire extinguisher.

IS : 933  Specification for portable chemical foam fire extinguisher.


IS : 2171  Specification for portable fire extinguishers dry powder (cartridge type)

IS : 2190  Selection, installation and maintenance of first aid fire extinguishers – Code of practice.

IS : 2871  Specification for branch pipe, universal, for fire fighting purposes.

IS : 2878  Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted).
<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 3844</td>
<td>Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises.</td>
</tr>
<tr>
<td>IS : 5290</td>
<td>Specification for landing valves.</td>
</tr>
<tr>
<td>IS : 5714</td>
<td>Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting.</td>
</tr>
<tr>
<td>IS : 8423</td>
<td>Specification for controlled percolation type hose for fire fighting.</td>
</tr>
<tr>
<td>IS : 10658</td>
<td>Specification for higher capacity dry powder fire extinguisher (trolley mounted).</td>
</tr>
<tr>
<td>IS : 11460</td>
<td>Code of practice for fire safety of libraries and archives buildings.</td>
</tr>
<tr>
<td>IS : 5514 (Parts 1 to 7)</td>
<td>Reciprocating internal combustion engines : Performance.</td>
</tr>
<tr>
<td>IS : 3589</td>
<td>Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).</td>
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<tr>
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<td>Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</td>
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</tr>
<tr>
<td>IS : 11149</td>
<td>Rubber Gaskets</td>
</tr>
</tbody>
</table>
ELECTRICAL SPECIFICATION

1. GENERAL

These special conditions are intended to amplify the General Conditions of Contract, and shall be read in conjunction with the same. For any discrepancies between the General Conditions and these Special Conditions, the more stringent shall apply.

2. SCOPE OF WORK

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Owner’s site representative. The contractor shall furnish all labour, materials and equipment (except those to be supplied by the owner) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete electrical system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The electrical system shall comprise of the following:

   a. All conduit work including junction boxes, outlet boxes and wiring for lighting and power circuit.

   b. Switches, plug sockets, cover plates and other wiring accessories.

   c. LT Cables Mains and Sub-Mains.

   d. LT panel, Main Distribution / Sub Distribution panels, Final Distribution panels & Capacitor Panels.

   e. Cables on cable trays and / or within suspended ceiling spaces including installation, cable trays, hangers, supports, cable terminations and all fixing accessories.

   f. Earthing (Grounding) System.

   g. Lightning Protection System.

   h. Supply and installation of Lighting Fixtures

   i. Supply and installation of conduiting & cabling for Voice & Data Network.

   j. Supply and installation of conduiting & cabling for FAS,PA CCTV, MATV System

   k. Supply and installation of Gas suppression System
I. UPS system  
m. Solar system  
n. Testing and commissioning.

3. ASSOCIATED CIVIL WORKS

Following civil works associated with Electrical installation are excluded from the scope of this contract except for all minor civil work like wall chasing by wall chaser, making holes etc. for installation of conduits/cables and making good. These shall be executed by other agencies in accordance with approved shop drawings of, and under direct supervision of the contractor.

i. RCC Trenches inside Sub-station and LT panel room including cable supports for lying of LT cables.

ii. PCC foundation blocks with angle iron framework edging for all power control centers and motor control centers.

Airtight fire doors shall be as per FIRE norms and requirement of CFO for Sub-Stations & LT panel room. However these will be of minimum 2 hour fire rating as per I.E. Rules 1956.

iv. Repair of all disturbed surfaces/openings made by Contractor.

4. BUILDING AUTOMATION SYSTEM (BAS IF APPLICABLE)

The scope of the Contractor related to BAS shall be to include the following for the interface to Building Automation System.

i. Stop/Manual/ Auto switch along with potential free contacts for monitoring the manual operation status (wherever applicable), to be provided for that equipment whose start / stop is controlled by Building Automation System.

ii. Potential free ‘NO’ contacts for monitoring ‘Run’ status of equipment wherever required.

iii. The installation of current transformer & Transducer along with wiring between Current Transformer & Transducer up to the terminal block shall be provided by the contractor. All transducers shall be supplied by BAS contractor.

iv. The low voltage BAS Cables shall be brought up to the electric panel by BAS contractor and all terminations into the electrical panels shall be made by contractor after satisfying himself of the wiring system. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the Electrical system, lies solely with the contractor.

5. PROJECT EXECUTION AND MANAGEMENT

The Contractor shall ensure that senior planning and erection personnel from his organization are assigned exclusively for this project. The Contractor shall appoint one Project Manager holding senior management position in the organization. He shall be assisted on full time basis by a minimum of two electrical engineer & three senior supervisors. The entire staff shall be posted at site on full time basis. Separate ID card to be given by the Contractor to each worker working on site.
The project management shall be through modern technique. The Contractor’s office at site shall be fully equipped with fax, computers & plotter and shall prepare proper bar chart and completion schedules to be submitted & ensure timely completion. Erection engineer and supervisors shall be provided with mobile communication system so that they can always be reached.

For quality control & monitoring of workmanship, contractor shall assign at least one full-time engineer who would be exclusively responsible for ensuring strict quality control, adherence to specifications and ensuring top class workmanship for the electrical installation. Contractor shall furnish details of licenses of supervisors/workmen to be employed at site.

6. PERFORMANCE GUARANTEE

The contractor shall carry out the work in accordance with the Drawings, Specifications, Schedule of Quantities and other documents forming part of the Contract.

The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required result.

The contractor shall guarantee that the Electrical system as installed shall perform to complete satisfaction of the owner. The guarantee shall be submitted in the proforma given in Appendix - II.

Complete set of architectural drawings is available in the Architect/Consultant’s office and reference may be made to same for any details or information. The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity; also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.

At the close of the work and before issue of final certificate of virtual completion, the contractor shall furnish written performance guarantee against defective materials and workmanship for a period of one year from date of testing, commissioning and handing over. The guarantee shall be submitted in proforma given in Appendix - II. The Contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to Owner the following:

a. Any defective work or material supplied by the Contractor.

b. Any material or equipment damaged or destroyed because of defective workmanship by the Contractor.

7. BYE-LAWS AND REGULATIONS

The work shall be carried out to the satisfaction of the Owner’s site representative and in accordance with the Specifications, Regulations of the Electric Supply Authority, Indian Electricity Rules and Regulations, latest Indian Standards and as per the requirements of the Chief Fire Officer.

8. FEES AND PERMITS

The Contractor shall pay any and all fees and obtain permits apply & get load sanction as required for the installation of this work. On completion of the work, the contractor shall obtain and deliver to the Owner, certificate of final inspection and approval by the local electricity authority (CFO/ Municipal, State/Central govt. whichever is applicable)
9. **DRAWINGS**

The Electrical Drawings listed under Appendix-I, which may be issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of equipment, electrical points & fixtures.

The contractor shall follow the tender drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.

Maximum headroom and space conditions shall be maintained at all points. Where headroom appears inadequate, the contractor shall notify the Architect/Consultant/Owner’s site representative before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and contractor shall rectify the same at his own cost.

The contractor shall examine all architectural, structural, plumbing, HVAC and other services drawings and check the as-built works before starting the work and report to the Owner’s site representative any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the Architect/Consultant/Owner’s site representative without additional cost to the Owner.

10. **SPECIFICATIONS**

The Specifications shall be considered as part of this contract. The Drawings indicate the extent and general arrangement of power distribution, location of lighting fixtures, controlling switches, wiring system, cabling and earthing. These drawings are essentially diagrammatic. The Drawings indicate the point of termination of conduit runs and broadly suggest the routes to be followed. The work shall be installed as indicated on the Drawings. However, any change found essential to coordinate the installation of this work with other trades shall be made without any additional cost to the Owner. The data given herein and on the Drawings is as exact as could be secured, but its complete accuracy is not guaranteed. The drawings are for the guidance of the contractor, exact locations, distances and levels shall be governed by the site conditions and the Architectural & Interior layouts.

11. **SHOP DRAWINGS**

11.1 All the shop drawings shall be prepared on computer through AutoCAD System based on Architectural Drawings, site measurements and Interior Designer’s Drawings. Within four weeks of the award of the contract, contractor shall furnish, for the approval of the Architect/Consultant, two sets of detailed shop drawings of all equipment and materials including layouts for all conduit layouts, distribution panels, switchboards, cabinets, special pull boxes, cable trays and any other requirement to be fabricated or purchased by the contractor.

11.2 These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Architect/Consultant/Owner’s site representative. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work.
by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III.

When the Architect/Consultant makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check print, for approval. The contractor shall submit further six sets of shop drawings to the Owner’s site representative for the exclusive use by the Owner’s site representative and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material/equipment/installation.

11.3 Shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

11.4 Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

11.5 Samples of all materials like conduits, accessories, switches, wires, control cables etc. shall be submitted to the Owner’s site representative prior to procurement. These shall be submitted in two sets for approval and retention by Owner’s site representative and shall be kept in their site office for reference and verification till the completion of the Project.

11.6 Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

11.7 Where the contractor proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, wiring or any other part of the mechanical, electrical or architectural layouts; all such re-design, and all new drawings and detailing required therefore, shall be prepared by the contractor at his own expense and gotten approved by the Architect/Consultant/Owner’s site representative.

11.8 The contractor shall extend full cooperation to HVAC contractor in preparation of his coordinated services drawings. He shall issue floppies and hard prints of his shop drawings to HVAC contractor well in advance to complete the co-ordinated services drawings in accordance with schedule prepared by the Owner site representatives. Where the work of the contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Owner’s site representative, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor
installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Owner.

11.9 Within two weeks of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this contract. The Project Manager shall make recommendation to Owner for acceptance of anticipated variation in contract amounts and also advise Owner to initiate action for procurement of spare parts and tools at the completion of project.

12. ACCESSIBILITY

   The Contractor shall verify the sufficiency of the size of the shaft openings, clearances in wall cavities and suspended ceilings for proper installation of his conduits cables, cable trays, panels etc.. His failure to communicate insufficiency of any of the above shall constitute his acceptance of sufficiency of the same. The Contractor shall locate all equipment, which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed control damper, valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Contractor shall make all the necessary repairs and changes at his own expense. Access panel shall be standardized for each piece of equipment / device / accessory and shall be clearly nomenclatured / marked.

13. MATERIALS AND EQUIPMENT

   All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per Appendix - III.

   The Contractor shall be responsible for the safe custody of all materials and shall insure them against theft or damage in handling or storage etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Owner’s site representative within 15 days of the award of the contract. Any item which is proposed as a substitute, the contractor shall state the credit, if any, due to the Owner in the event the substitution is approved. All changes and substitutions shall be requested in writing and approvals obtained in writing from the Owner’s site representative.

14. MANUFACTURERS INSTRUCTIONS

   Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, manufacturer’s instructions shall be followed in that case.

15. COMPLETION CERTIFICATE

   On completion of the electrical installation a certificate shall be furnished by the Contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local, state/central govt./municipal / fire authorities concerned.
16. INSPECTION AND TESTING

The Owner may carry out inspection and testing at manufacturer’s works for this contract. No equipment shall be delivered without prior written confirmation from the Owner’s site Engineer. In case factory inspection is carried out then all travelling and lodging expenses for two persons one from owner and one from consultants shall be borne by the Contractor, also all expenses related to testing shall be to Contractor account. Tests on site of completed works shall demonstrate the following:

That the equipment installed complies with specification in all respect and is of the correct rating for the duty and site conditions.

That all items operate efficiently and quietly to meet the specified requirements.

That all circuits are fully protected and that protective devices are properly co-ordinated.

That all non-current carrying metal parts are properly and safely grounded in accordance with the specification and appropriate Codes of Practice.

The contractor shall provide all necessary instruments and labour for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the Owner and shall provide test certificate signed by a authorised person. Such test shall be conducted on all materials and equipment and tests on completed work as called for by the Owner at contractor’s expenses unless otherwise called for.

If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification of the same. Owner Site Engineer’s decision as to what constitutes a satisfactory installation shall be final.

All tests shall be carried out by a test house approved by the Owner / Consultants.

17. COMPLETION DRAWINGS

Upon completion of the work and before issuance of certificate of virtual completion the contractor shall submit to the Owner’s site representative four sets of layout drawings in progressive manner for individual systems drawn at approved scale indicating the complete wiring system as installed. Drawings shall be prepared on AUTO-CAD (latest version). Along with the hard copies, the contractor shall submit copies of all drawings on CD and one set of all drawings on RTF shall also be submitted. These drawings must provide:

a. Substation equipment layout & all power distribution panel layout.

b. Single line power distribution diagram including control wiring.

c. Cable Trays with number and size of cables installed.

d. Run and size of conduits, inspection, and junction and pull boxes.

e. Raceways and Junction Boxes.

f. Number and size of conductors in each conduit with phase identification.
g. Location and rating of sockets and switches controlling the lighting and power outlets

h. Location and details of distribution boards/panels, mains, switches along with phase balancing details.

i. A complete wiring diagram as installed and single line diagrams showing all connections in the complete electrical system.

j. Location of all earthing stations, route and size of all earthing conductors manhole.

k. Layout and particulars of all HT & LT cables.

l. Instruction, maintenance and operation manuals including maintenance schedule for all equipment. Testing & commissioning reports of all electrical equipment.

18. OPERATING INSTRUCTION & MAINTENANCE MANUAL

Upon completion and commissioning of part Electrical system the contractor shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer’s operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals; one each for retention by Consultant and Owner’s site representative and two for Owners Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4-year period of maintenance of each equipment.

19. ON SITE TRAINING

Upon completion of all work and all tests, the Contractor shall furnish necessary operators, labour and helpers for operating the entire installation for a period of thirty (30) working days of ten (10) hours each, to enable the Owner’s staff to get acquainted with the operation of the system. During this period, the contractor shall train the Owner’s personnel in the operation, adjustment and maintenance of all equipment installed.

20. MAINTENANCE DURING DEFECTS LIABILITY PERIOD

20.1 Complaints

The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

Repairs

All equipment that require repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs concurrently with the defects liability period, all replacement parts and labour shall be supplied promptly free-of-charge to the Owner.

21. UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for...
every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all temperatures, pressures, humidity, power consumption. Starting and stopping times for various equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Contractor shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the Owner’s site representatives/Consultant’s review. This shall include the type of service planned to be offered during Defects Liability Period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the Management.

The tenderer shall include a list of other projects where such an Operation Assistance has been provided.

22. OPERATION AND MAINTENANCE

Contractor may be required to carry out the operation of the Electrical installation for the defects liability period. Further, he may also be required to carry out operation and all inclusive maintenance of the entire system for a period of three years beyond the defects liability period.

22.1 Operation contract (Electrical System)

10 hours a day, year round during working office hours for full load

i. 14 hours a day, year round during non-work hours for part load.

ii. All stand-by equipment to be operated as per mutually agreed programme.

iii. Proper entry and upkeep of relevant log books.


v. Proper housekeeping of all areas under the contract.

vi. Prepare daily consumption report and summary of operation.

22.2 Terms of payment

i. Monthly at the end of each month on pro-rata basis.

22.3 All Inclusive Maintenance Contract

Scope

The AMC shall cover all the items installed by the contractor including replacement of all switches, fittings etc. consumable like bulbs, tubes, oil etc. shall be excluded.

Routine Preventive Maintenance Schedule to be submitted
i. Schedule to cover manufacturer’s recommendation and/or common engineering practice (for all plant and machinery under contract).

ii. Plant and machinery history card giving full details of equipment and frequency of checks and overhaul.

iii. Monthly status report.

iv. Entire Electrical installation to be repainted in fourth year (from commissioning) before the expiry of operation and maintenance contract.

Uptime during maintenance contract

i. 98% uptime of all systems under contract.

Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.

iii. There shall be no reimbursement for the extended period.

Break-downs shall be attended to within ten hours of reporting.

Manpower

i. Adequate number of persons to the satisfaction of the Owner’s site representative shall be provided including relievers.

ii. Statutory requirements of EPF, ESIC and other applicable labour legislations to be complied with; and monthly certification to that effect to be submitted.

iii. Duty allocation and Roaster control shall be contractor’s responsibility.

iv. No overtime shall be payable by Owner for any reason whatsoever.

e. Shut Downs

i. Routine shut downs shall be permitted only as allowed by the Chief Engineer.

ii. Contractor shall be at liberty to carry out routine maintenance as and when required but with prior permission of the Owner.

f. Payment Terms

i. Quarterly payment at the beginning of each quarter on pro-rata basis.

23. METHOD OF MEASUREMENT

The works shall be measured in accordance with relevant IS codes. Notwithstanding any general or local custom, except where otherwise specifically described or prescribed in the contract.

24. DEMONSTRATION TO OWNER

At completion, devices subject to manual operation shall be operated atleast five times in presence of Owner’s site representative to demonstrate satisfactory operation.
25. TOOLS AND TACKLES

The Contractor shall provide and install all necessary hoists, ladders, scaffolding, tools, tackles, all transport for labour and materials and plant necessary for the proper execution and completion of the work to the satisfaction of the Owner’s site representative.

26. PARTIAL ORDERING

Owner through the Architect/Consultant/Owner’s site representative reserves the right to order equipment and material from any and all alternates, and/or to order high side and/or low side equipment and materials or parts thereof from one or more tenderers.

TECHNICAL SPECIFICATIONS

ELECTRICAL SYSTEM

1. INTERNAL WIRING

1.1 System of Wiring

The system of wiring shall consist of PVC insulated copper stranded conductor flexible FRLS wires in metallic / nonmetallic (Rigid heavy Duty ISI -marked fire retarded PVC Conduits of minimum 2mm Wall thickness and Sizes starting from 20 mm diameter) conduits and shall be concealed or surface mounted above false ceiling as called for.

1.2 General

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the noninterference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner’s site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

1.3 Metal Conduits & Accessories

1.3.1 Conduits

Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 & 2. 16/14 (16 gauge up to 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed GI or MS conduits as specified on schedule of quantities shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.
Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Note:
Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan.

1.3.2 Joints

All jointing shall be subject to the approval of the Owner’s site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberised bushes shall be used in the conduit entry and exit from DBs, switch boxes etc, so that wires are protected from damage to insulation of the incoming and outgoing wires.

1.3.3 Recessed Or Exposed Conduits

All conduits shall be as per Schedule of Quantities.

1.3.4 Flexible Conduits

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature upto 150 deg. C and intermittent temperature upto 200 deg. C. The flexible conduit shall be corrosion resistant as per IS-3480 & BS-731.

1.4 PVC Conduit and Accessories

PVC Conduit

Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty with minimum wall thickness of 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All conduits used shall be ISI-marked and shall not be less than 20 mm diameter.

PVC conduit shall be used for all concealed / embedded installation.

PVC Conduit Accessories

Accessories used for conduit shall be of an approved brand and type complying to relevant IS code.

All accessories used shall be of standard white or black colour, identical to conduit used.

Plain conduits shall be jointed by slip type of couplers with manufacturer’s standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.
PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

1.5 Bends in Conduit

Where necessary, bends or diversions may be achieved by means of bends and/or circular cast iron boxes with inspection cover and with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non-uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enameling/Galvanising of the Conduit is not damaged.

1.6 Fixing of Conduits

All conduits shall be installed so as to avoid exposure to steam, hot water or any other process pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, rodents and insects, insects or any other foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 1000 mm, and on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface to the entire satisfaction of Owner.

1.7 Switch outlets and Junction Boxes

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 1.6 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in SOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall generally be of 50mm depth subject to maximum depth of 65 mm.

1.8 Inspection Boxes
50 mm dia inspection boxes and pull boxes shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

1.9 Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided along with the laying of recessed conduit.

1.10 Conductors

All PVC insulated copper conductor flexible FRLS, as specified in SOQ, wires shall conform in all respects to Standards as listed under sub-head Indian Standards and shall be IS approved and ISI marked.

1.11 Bunching of Wires

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate. Each Power/ Light Circuit’s Neutral shall be individual per Circuit and shall not be looped from any other Circuit.

1.12 Drawing Conductors

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below:

<table>
<thead>
<tr>
<th>Size of wires Nominal Cross Section Area (Sq. mm.)</th>
<th>Maximum number of wires within conduit size(mm)</th>
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</table>
Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid nonmetallic or PVC Conduits are given below:

<table>
<thead>
<tr>
<th>Size of wires Nominal Cross Section Area (Sq. mm.)</th>
<th>Maximum number of wires within conduit size(mm)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>20</td>
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<td>1.5</td>
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Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/reduced for convenience in connecting into terminals. The terminals shall have sufficient cross sectional area to take all strands and its connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

Conductors having nominal cross sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts with brass washers shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring licence to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians’ / Wireman’s / Cable Jointer’s licence to Owner.
All wires and cables shall be embossed with the manufacturer’s label with ISI mark and shall be brought to site in original packing. For all internal wiring. PVC insulated wires of 1100 volts grade (FRLS) shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 1.5 sq.mm copper. Separate neutral to be pulled for each circuit.

1.13 Joints

All joints shall be made at main switches, distribution boards. Socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

1.14 Mains and Sub-Mains

Mains and sub MAINS cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and calculations shall be submitted for verification. An independent earth wire of the proper rating shall be provided for every single-phase sub-main. For every 3-phase sub-main, 2 Nos. earth wires of proper rating shall be provided along with the sub-main. The earth wires shall be drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance. Where ever necessary, powder-coated 1.6 mm thick sheet steel covering (also called trunking) shall be provided to cover the group of conduits and cables entering and exiting the Wall mounted/Floor mounted Sub DBs, DBs, and FDBs, so that the installation looks neat. The colour of such sheet steel covering (trunking) shall be matching with the colour of the SDBs, DBs and FDBs.

1.15 Load Balancing

Balancing of circuits in three phase installation shall be as planned by the Consultants in the tender drawings and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

1.16 Colour Code of Conductors

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

2. SWITCHES, RECEPTACLES (MODULAR), LIGHTING FIXTURES

All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat MS strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load shall be restricted to maximum 800 watts.
per switch & maximum 1500 watts per circuit. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

All switches and sockets are modular type which shall be made of fire retardant; self-extinguish polycarbonate plastic, able to withstand the glow wire test at 960 deg. C.

The switches shall confirm IS 3854 :1997, The internal design of terminals and contact shall make the switch capable of high overload conditions, The switch shall be of flush type with silver inlay contact on pure copper.

All switches, sockets, telephone outlets, TV controlling the lights or fans shall be connected to the phase wire of the circuit. Switches shall be located at 1200mm above finished floor level unless otherwise indicated on drawings.

Switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.

Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.

Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.

Switches for external use shall be of weatherproof construction with IP65 rating unless otherwise specified. Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.

Switches shall be rated for 6 Amps (minimum light switch rating 6A), 16 Amps or 20 Amps (as determined by circuit load). Inductive lighting circuit shall be assessed at twice the steady state connected load current.

2.1 SOCKET OUTLET

Socket outlets shall be of the three pin. All socket shall fully comply with IS 1293: 2005 specifications.

The switch controlling the socket outlet shall be on the phase wire of the circuit and not more than two socket outlets of 16 amps shall be connected on one circuit. An earth wire shall be provided along with the circuit wires and shall be connected to earthing screw inside the box. All sockets shall be shuttered type.

a. Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.

b. The switch controlling the socket outlet shall be on the `Live’ side of the line.

c. 6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level as desired by the Architect. The switch for 6 and 16 amps, socket outlet shall be kept along
with the socket outlet. However, in special case, if desired by the Architect the 6 amp. socket outlet can be placed at the normal switch level.

16 amps socket outlet in the kitchen of the residential or commercial buildings shall be fixed at any convenient height above working platform or as specified in drawings / schedule of equipments.

In a room containing a fixed bath or shower, there shall be no socket outlet and there shall be no provision for connecting a portable appliance. Any stationary appliance connected permanently in the bath room shall be controlled by an isolator switch or circuit breaker having outlets at such location where water / moisture does not effect. Generally, switches and outlets shall be planned at a minimum distance of 1.5 Metre away from any water supply outlet, so that splashed water may not affect the live installation.

d. Where socket outlets are placed at lower level, they shall be enclosed in a suitable metallic box with the system of wiring adopted or shutter type sockets shall be provided as specified.

e. In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.

f. Conductors connecting electrical appliance with socket outlet shall be flexible twin cord with an earthing cord which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.

g. Where use of shutter type of interlocking type of socket is required for any special installation, the items should be separately and specifically listed in the Schedule of Quantities of that particular work.

h. All switches, sockets, telephone and TV outlets etc. shall be fixed on 3mm thick phenolic laminated sheet cover unless otherwise called for in drawing or BOQ. Flush cover plate shall be secured to the box with counter sunk brass screws & cup washers.

i. All 5 and 15Amp socket outlet shall be modular type 5/6 pin respectively. Each outlet shall have a switch located beside the socket preferable on the same flush cover plate.

j. The earth terminal of the socket shall be connected to the earth wire.

Generally switch socket outlets shall be positioned 300 mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400 mm above floor level or 150 mm above counters or benches as per requirement unless otherwise specified.

2.2 LIGHTING FIXTURES & ACCESSORIES

The light fixtures and fittings shall be LED type assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer’s instructions and to the satisfaction of the Project Manager.

2.2.1 Scope:

Scope of work under this section shall include inspection at suppliers/manufacturer’s premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and
commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

2.2.2 Standards:

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

<table>
<thead>
<tr>
<th>Description</th>
<th>IS No.</th>
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</thead>
<tbody>
<tr>
<td>Industrial lighting fittings with metal reflectors</td>
<td>IS - 1777</td>
</tr>
<tr>
<td>Decorative lighting outfits</td>
<td>IS – 5077</td>
</tr>
<tr>
<td>Bayonet lamp holders</td>
<td>IS - 1258</td>
</tr>
<tr>
<td>Bi-pin lamp holders for tubular fluorescent lamps</td>
<td>IS - 3323</td>
</tr>
<tr>
<td>Luminaries – General requirement</td>
<td>IS – 10322 (Part-1)</td>
</tr>
<tr>
<td>Luminaries – Constructional requirement</td>
<td>IS – 10322 (Part-2)</td>
</tr>
<tr>
<td>Luminaries – Screw and Screwless termination</td>
<td>IS – 10322 (Part-3)</td>
</tr>
<tr>
<td>Luminaries – Methods of Tests</td>
<td>IS – 10322 (Part-4)</td>
</tr>
<tr>
<td>Particular requirement – General purpose Luminaries</td>
<td>IS – 10322 (Part-5/Sec-1)</td>
</tr>
<tr>
<td>Particular requirement – Recessed Luminaries</td>
<td>IS – 10322 (Part-5/Sec-2)</td>
</tr>
<tr>
<td>Particular requirement – Luminaries for Road and Street lighting</td>
<td>IS – 10322 (Part-5/Sec-3)</td>
</tr>
<tr>
<td>Particular requirement – Portable General purpose</td>
<td>IS – 10322 (Part-5/Sec-4)</td>
</tr>
</tbody>
</table>

2.2.3 Light Fittings-General Requirements:

a. Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.

b. Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ballasts.

c. All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters,
etc. Outdoor type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.

d. Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.

e. All hardware used in the fitting shall be suitably plated or anodized and passivated.

f. Earthing: Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

g. Painting/Finish: All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.

h. The housing shall be powder coated/stove-enameled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.

i. Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

2.2.4 Light Fittings – Special Requirements

All lighting fixture shall be LED type with minimum 80% efficancy.

Box Channel Type Industrial Fittings

Box type slim line channel must be in screwless construction manufactured from M.S. CRCA sheet steel powder coated with MS CRCA cover, powder coated white. Light reflection surface in Box/Channel type fittings shall be in a POLYESTER PRECOATED STEEL having a reflection factor of not less than 80%. SCREWLESS DESIGN & CONSTRUCTION Light fixtures shall be preferred due to their ease of maintenance, especially for box/channel for box/channel type fixtures.

Moisture Proof Industrial Fittings

Surface mounted totally enclosed moisture proof fixtures must be in polycarbonate body and diffuser with transparent prismatic interior and smooth exterior and frosted end. Fixture must be completely sealed with polyurethane double gasket to achieve IP 65 protection. Fixture is complete with CRCA steel white powder coated / enameled finish reflector.

2.2.5 Accessories for Light Fittings - Reflectors

The reflectors shall be made of CRCA sheet steel/aluminium /Silvered glass/Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of
steel shall have stove enameled/ vitreous enameled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enameled /mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches / blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

2.2.6 Installation

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer.

All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900 mm length. Exact lengths required shall be provided to suit the site requirement.

2.2.7 The Testing

After all lighting fixtures are installed and are connected their respective switches, test all fixtures to ensure operation on their correct switch in the presence of the Engineer. All un-operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer.

3. MEDIUM VOLTAGE 1.1 KV GRADE XLPE / PVC CABLES

3.1 General

The MV cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Standard Specifications and cable manufacturer’s instruction.

3.2 Material

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed of 1100 volts grade as asked for in the schedule of quantities. Cables upto 6 sq.mm shall be with copper conductor and 10 sq.mm and above shall be with aluminum conductor.

3.3 Technical Requirements

3.3.1 All XLPE Aluminum/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows:

a. Stranded Aluminum /Copper conductor in case of 10 sq.mm. And above whereas solid conductor in case of 10 sq.mm. and below.

b. Cores laid up

c. The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.

d. Armoring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanized steel wires or galvanised steel strips. (In single core cables
used in A.C. system armouring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)

e. The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-1984 extruded to form the outer sheath.

3.3.2 Conductor shall be of electrolytic Aluminium/Copper conforming to IS: 8130 and are compact circular or compact shaped.

3.3.3 Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.

3.3.4 In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.

3.3.5 Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.

3.3.6 Armouring shall be of galvanised steel wire/flat.

3.3.7 Repaired cables shall not be used.

3.3.8 Current ratings of the cables shall be as per IS: 3961.

3.3.9 The XLPE insulated cables shall conform to latest revision of IS and shall be read along with this specification. The Conductor shall be stranded Aluminium/Copper circular/sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.

3.3.10 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

3.3.11 Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.

3.3.12 Cables shall be supplied in non-returnable wooden drums as per IS: 10418.

Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

3.3.13 The product should be coded as per IS :- 7098 Part-I as follows :-

Aluminium Conductor A
XLPE Insulation 2X
Steel round wire armour W
Steel strip armour                            F
Steel Double round wire armour               WW
Steel Double strip armour                    FF
Non-magnetic (Al.) round wire armour        Wa
Non-magnetic (Al.) strip armour              Fa
PVC outer sheath                             Y

3.4 Inspection

All cables shall be inspected by the contractor upon receipt at site and checked for any damage during transit.

3.5 Joints in Cables

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing. This apportioning shall be got approved by the Owner’s site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type joints shall be made. The location of such joints shall be got approved from the Owner’s site representative and shall be identified through a marker.

3.6 Jointing Boxes for Cables

Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

3.7 Jointing of Cables

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures’ instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

3.8 Cable End Terminations

Cable end termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type.

3.9 Bonding of Cables

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armour clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.
3.10 CABLE INSTALLATION

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

3.10.1 Laying of Cables on Cable Trays

The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables shall be tagged for identification with aluminum tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant sealant and shall be painted with fire retardant paint up to one meter on all joints, terminations and both sides of the wall crossings by “VIPER CABLE RETARD”.

3.10.2 Laying of Cables in Ground

The width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be worked out by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches: The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be leveled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be removed by ‘Flaking’ i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be...
be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.

Back Filling: The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

3.11 Cables inside Building

Cables inside buildings shall be laid on the cable trays. All cables passing through walls shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length.

3.12 Route Marker

Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.

Route marker shall be of cast iron painted with aluminum paint. The size of marker shall be 100 mm dia with “Cable” and voltage grade inscribed on it.

3.13 Cable Trays

Ladder and perforated type Cable Trays shall be of Hot dip Galvanized type and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below:

Cable trays shall be hot deep galvanized as per Specification given under 3.9.

900 mm wide
- Runners 25 x 100 x 25 x 3 mm
- Rungs 2# 20 x 40 x 20 x 2.5 mm 250 mm C/C
- Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

750 mm wide
- Runners 20 x 75 x 20 x 2.5 mm
- Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
- Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

c) 600 mm wide
- Runners 20 x 75 x 20 x 2.5 mm
- Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5 mm GI angle.

d) 450 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5 mm GI angle.

f). Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.

   i. 600 x 40 x 40 x 2 mm thick
   ii. 450 x 40 x 40 x 2 mm thick
   iii. 300 x 40 x 40 x 2 mm thick
   iv. 150 x 40 x 40 x 2 mm thick

Note: Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

3.14 Specification for Hot Dip Galvanizing Process

(For Mild Steel Used For Earthing, Cable Trays Or Junction Boxes For Electrical Installation.)

   General Requirements

   I. Quality of Zinc

      Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

   II. Coating Requirement

      Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

      The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

      The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

      Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

3.15 Fire retardant Cable Paint & Fire Barrier

   The fire retardant paint / barrier shall be listed by independent test agencies such as UL, FM or OPL and be tested to, and pass the criteria of ASTM E 814 (UL1479) standard test method for fire test
through-penetration fire stops and ASTM E 1996 (UL 2079) standard test method for fire resistive joint system/

3.15.1 Fire retardant cable Paint

The Fire resistant cable coating / painting shall be intumescent / ablative, water based compound. The coating shall expand up to 10 times, supplied in a manufacturer seal container indicating manufacturing and expiry dates. The coating material shall be non-toxic, asbestos free, & halogen free and shall have good mechanical strength. The colour of paint shall be white and density of coating shall be 1.3kg/ltr, coating shall have a snap time of 30 minutes, the expansion shall begin at 230 deg.C and it shall have a oxygen index of 41%.

Coating shall be applied by ordinary paint brush after cleaning the cables of dust and oil.

Deposition. A minimum textured finish of 3 mm wet film thickness shall be achieved by applying the material in 2-3 layers leaving intervals of 2 to 8 hours depending upon the moisture and thickness, moisture and temperature hours between each coat.

3.15.2 Fire Barrier sheet for floor and wall sealing

The framing & fixing part of fire barrier sheet shall be very simple & directly fixed around walls & floors by help of anchored bolts & washer. For 2 hour fire rating the fire barrier sheet shall be minimum 7.62 mm thick and shall be cut as per the profile of penetration and opening. The small gap left around the penetration shall be closed with fire rated soft &mouldable putty. Fire barrier must be design on the intumescent technology to seal larger penetration through the fire rated walls &floors. Fire barrier must be a composite construction with the quality incorporated with organic/ inorganic fire resistive elastomeric sheet with specific gravity of 1.6 gm/ cubic centimeter.

3.16 Testing of Cables

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

Insulation Resistance Test.

Continuity resistance test.

Sheathing continuity test.

Earth test.(in armoured cables)

Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner’s site representative.

Insulation Resistance Test( Sectional and overall)
b) Continuity resistance test.
c) Sheathing continuity test.
d) Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner’s site representative, results will be noted and signed by all present and record be maintained.

(A) DISTRIBUTION PANELS/BOARDS

Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by an approved manufacturer. CPRI certificate shall be made available.

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 Construction Features

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self-threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum operating clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest operating height.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit
connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metalname plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4.2 Bus Bar Connections

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium /copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 kV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosettingplastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 0.8 A/sq.mm for aluminium and 1.4 A/sq.mm for copper busbars.

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C.

4.2.1 Temperature - Rise Limit

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches andcircuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

4.3 Cable Compartments
Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

4.4 Air Circuit Breakers (ACB)

The ACB shall conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V + 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip freemanual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

Circuit breakers shall be designed to ‘close’ and ‘trip’ without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breakers shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.
Test Position: Main isolating contacts are isolated but control contacts are still engaged.

Isolated Position: Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features shall be incorporated:

Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.

Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.

All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

All Switchgear module front covers shall have provision for locking.

Switchgear operating handles shall be provided with arrangement for locking in ‘OFF’ position.

Protections

The breaker should be equipped with micro-controller based, communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall generally have following features and settings however for exact requirement of protection releases, reference shall be made to SOQ:

a. True RMS Sensing

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics:
A variety of pick-up and time delay settings shall be available to define the current thresholds and the
delays to be set independently for different protection zones thereby achieving a close-to-ideal
protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self powered

The release shall draw its power from the main breaker CTs and shall require no external power supply
for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking.
This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent
discrimination between breakers. This feature enables faster clearance of fault conditions, thereby
reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the
damage to the system. To implement ZSI manufacturer should supply all related equipment like power
supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release
without tripping the breaker.

g. The release shall meet the EMI / EMC requirements.

h. The setting range of release shall be generally asfollows:

<table>
<thead>
<tr>
<th>Type of Protection</th>
<th>PICK-UP CURRENT</th>
<th>TIME DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Time</td>
<td>0.4 to 1.0 times In (Ir)</td>
<td>0.5 to 30 sec at 6 Ir</td>
</tr>
<tr>
<td></td>
<td>Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00.</td>
<td>Steps 0.5, 1, 2, 4, 6, 8, 12, 18, 24 and 30 secs</td>
</tr>
<tr>
<td></td>
<td>Operating Limit: 1.05 to 1.2 times Ir</td>
<td>Tolerance: Corresponding to ±10% of current.</td>
</tr>
<tr>
<td>Short Time</td>
<td>2 to 10 times Ir</td>
<td>20 ms to 600 ms</td>
</tr>
<tr>
<td>Protection Type</td>
<td>Steps</td>
<td>Tolerance</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------</td>
<td>-----------</td>
</tr>
<tr>
<td>Instantaneous</td>
<td>2 to 12 times In</td>
<td>±10%</td>
</tr>
<tr>
<td>Ground Fault</td>
<td>0.2 to 0.6 time In</td>
<td>±10%</td>
</tr>
</tbody>
</table>

All incomer ACBs shall have following additional protections other than mentioned above.

Under and over voltage

Under and over frequency

Restricted Earth Fault protection

Trip Circuit supervision with PS class CT’s.

Undercurrent, (for DG set only)

Reverse power (for DG set only)

Phase sequence reversal

Load shedding and reconnection thru programmable contacts.

Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as
thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters:

Phase currents (running, avg& max) – All parameters in single window.

Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.

Release should be self-powered.

Release should have facility to select different type of IDMTL protection (DT, SIT, VIT, EIT, HVF) for better co-ordination with HT Breaker/Fuse.

Phase voltages (running, avg& max)

Energy & power parameters (active, reactive and apparent)

PF

Frequency

Maximum Demand ( KVA & KW)

Total Harmonics distortion

All O/G ACBs shall have following functions.

Protection

The ACB control unit shall offer the following protection functions as standard:

Long-time (LT) protection with an adjustable current setting and time delay;

Short-time (ST) protection with an adjustable pick-up and time delay;

Instantaneous (INST) protection with an adjustable pick-up and an OFF Position.

Current and time delay setting shall be indicated in amperes and seconds respectively On a digital display.

Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.

A LED bargraph shall simultaneously display the load level on the three phases.
A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

4.4.4 Safety Features

i. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

ii. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.

iii. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

iv. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

v. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

vi. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

vii. The insulation material used shall conform to Glow wire test as per IEC60695.

viii. The ACB shall provide in built electrical and mechanical anti-pumping.

ix. All EDO ACB’s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

4.5 Moulded Case Circuit Breaker (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2.

The breaker as supplied with ROM should meet IP54 degree of protection.
4.5.1 Current Limiting & Coordination

The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. The manufacturer shall provide both the discrimination tables and let-through energy curves for all.

Protection Functions

MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (adjustable thermal for overload and fixed magnetic for short-circuit protection) trip units.

Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units.

Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings.

Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)

Protection settings shall apply to all poles of circuit breaker.

All Microprocessor components shall withstand temperatures up to 125 °C

4.5.2 Testing

Original test certificate of the MCCB as per IEC 60947-1 & 2 or IS13947 shall be furnished.

Pre-commissioning tests on the switchboard panel incorporating the MCCB shall be done as per standard specifications.

4.5.3 Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switchboard.

a) Handle interlock to prevent unnecessary manipulations of the breaker.

b) Door interlock to prevent the door being opened when the breaker is in ON position.

c) Defeat-interlocking device to open the door even if the breaker is in ON position.

The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.

All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.

The trip command shall override all other commands.

4.6 Motor Protection Circuit Breaker (MPCB)
Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°9.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4. MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1. Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory). The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C)

4.7 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the
4.8 Residual Current Circuit Breaker Current Operated Type (RCCB)

i. System of Operation

Residual Current Circuit Breaker shall confirm to IEC 61008. RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer.

In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

ii. Mechanical Operation

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing/opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

iii. Neutral Advance Feature

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall break last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

iv. Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB/RCCB and the operating handle shall move to the "OFF" position.

4.9 Earthing

Earthing shall be provided as per IS:3043-1987.

4.10 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per BOQ confirming to IS Code No.5.

4.11 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.
4.12 Meters

i. All voltmeters and indicating lamps shall be through MCB’s.

ii. Meters and indicating instruments shall be flush type.

iii. All CT’s connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

4.13 Current Transformers

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

4.14 Potential Free Contacts

Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

4.15 Indicating Panel

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per relevant fault level and toggle switch.

4.16 Testing

Testing of panels shall be as per following codes:

i. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages up to and including 1000 VAC.

ii. IS: 13947: 1993 Degree of protection

iii. IS: 5578 & 11353:1985 Arrangement of bus bars.

4.17 Wiring

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing. Only FRLS wires shall be used.

4.18 Anti-Condensation Space Heaters
1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB’s or MPCB’s as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space heater with thermostat shall be provided in each cable alley of main distribution boards and sub distribution boards.

4.19 Installation

Installation of all LT panels shall include but not limited to the following to complete the installation, testing and commissioning:

- Transporting materials from stores to exact location of installation.
- Supply and installation of required base frame made of MS angle or channel sections and duly painted with black paint.
- Positioning, aligning, fixing, assembling, and installation of LT panel issued free of cost by Client after carrying out proper cleaning and inspection.
- Site supervision, testing for proper functioning / operation, and pre-commissioning tests.

4.20 Commissioning and onsite Testing

All switchboards shall be tested for dielectric test with 1000V megger.

All earth connections shall be checked for continuity.

All busbar connections shall be checked and tightened properly.

All cable terminations and terminal shrouding shall be checked if they are properly done.

The operation of protective devices shall be tested by secondary injection test.

The operation of circuit breaker shall be tested for all interlocks.

Functional test shall be done for all ACBs, MCCBs and other components.

Indicating lamps and meters shall be checked for proper working.

4(B) FINAL DISTRIBUTION BOARDS (FDB’s)

Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum dielectric strength of 2.5 KV / Sec. All Distribution Boards shall manufactured by a manufacturer listed in Appendix-I.

FDB’s shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 Construction Features

FDB’s shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor / outdoor installation, wall
mounting free standing type, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self-threading screws shall not be used in the construction of FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB’s in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

Final Distribution Boards shall comprises of the following:

A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB’s and RCCB’s etc.. Neutral bus bars & earthing bus bars required in the circuit. All busbars in the FDB shall be insulated type.

4.1.3 Service cable /enterconnection shall be part of the Distribution Boards.

4.1.4 The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

4.1.5 Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen & laundry and IP-55 for outdoor application.

4.1.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB’s and RCCB’s unless noted otherwise.

4.1.7 Phase segregation to be maintained in all three phase distribution boards as per 7 segment configuration & as per Chennai regulations.

4.1.8 Earthing shall be provided in each FDB’s.

4.2 Miniature Circuit Breaker (MCB)

For specifications refer Section 4A, clause 4.7

4.3 Residual Current Circuit Breaker Current Operated Type (RCCB)

For specifications refer Section 4A, clause 4.8
4.4 Earthing

Earthing shall be provided as per IS:3043-1987.

4.5 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

4.6 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.7 Testing

Testing of panels shall be as per following codes:

i. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.

ii. IS: 13947 : 1993 Degree of protection

4.8 Wiring

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

5. POWER FACTOR CORRECTION SYSTEM (WITH DETUNED FILTER)

5.1 Scope

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below:

5.2 Standard

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

5.3 Rating

100 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

5.4 Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle
supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

5.5 APFC Relay / Controller

Microprocessor based APFC relay (Intelligent VAr controller) shall have dual sensing so that on generator supply it can suitably switch to desired power factor and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features:

Controller shall provide thyristorized output of 8/16 stage.

Digital settings of parameters like PF, Switching time delay, Step limit etc.

LCD Display displaying PF/V/I/KVA/KW/KVAR temp./Harmonics (THD and Individual for Voltage and Current)

Indication of PF, preset parameters, Contactors switching operation and capacitors operating life.

Minimum threshold setting of 1% of CT current.

No-volt release.

Protective shut down in case of harmonic overload.

Shall have data logging for all Electrical parameter for 2 months.

Shall have RS 232 interface.

Output command shall have maximum 16 outputs.

Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

5.6 Construction

Each basic unit of heavy duty MPP Type capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Polypropylene film placed between 2 layers of metal foil and winding or shall have wave cut MPP design. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.
The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyester paint coated finish/ cylindrical Aluminium can. Each standard unit shall be provided with internal fuses (operation co-ordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of upto 5% on voltage and current waveforms shall not affect the life of capacitors. 440±10% variation in line voltage shall not affect the life of the capacitors.

5.7 Capacitors

Capacitor shall be 525 V and output shall be increased considering reactor suitability.

General specifications: 3 phase, delta connected, 50 Hz.

Capacitor shall be ISI marked.

Voltage: Shall be designed for minimum 520V and shall withstand system over voltage, increased voltage due to series reactor and harmonics.

Capacitor type: Super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnector in each individual capacitor cell.

MPP design, with wave cut technology with PSD for individual cell.

Overvoltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 5.1 of IS 13340-1993.

Overcurrent : 2.5 x In

Peak Inrush current withstand : 350 x In

Total watt-losses excluding discharge resistors:<0.45 W / k V Ar.

Temperature category: -25 deg.C to 70 deg.C or at D Class.

Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing / inert gas.

The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

5.8 Switching Module

Contactor switching module shall be capable of voltage peak withstand capacity of upto 2400 Vpk.

5.9 Terminals

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified. Or Sigut terminal shall be preferable.
5.10 Earthing

Two separate earthing terminals shall be provided for earth connection of each bank.

5.11 Low Voltage Filter Reactor

Filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 75. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature class H operation. The reactor coils shall be wound with high grade aluminum / copper and termination shall be provided with suitably designed copper bars.

5.12 Testing

The reactor shall be tested using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

5.13 Series Reactor

Application

LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical reasonance in LV electrical networks.

Construction, Testing & Protection

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60289/ IS-5553.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC / IS standards.

The permitted tolerance of inductance shall be ±5% of rated inductance value.

Reactor tuning factor shall be 5.67% and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows $2.08 \cdot \sum \eta$ with $L = 0.95 LN$

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

5.14 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating (minimum 1.8 times the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.
Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

5.15 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

5.16 Testing

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

5.17 Installation

i. Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

ii. All interconnections in the control panel shall be checked before commissioning.

iii. Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

iv. Insulation matting as per IS-15652 of an approved make platform shall be provided in front of the full length of the capacitor bank and control panel.

5.18 Testing & Commissioning

i. Insulation resistance shall be tested with a 1000 voltsmegger between phases and phase to earth.

ii. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.

iii. Each discharge resistor shall be tested for its working.

6. EARTHING
6.1 EARTHING

The system shall be TNS with four wire supply system (R,Y,B,N and 2 Nos. E) brought from the main LT Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switch gear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipelines, ducts, cable trays, stair case railing etc. shall be bonded to earth. All earthing shall be in conformity with IS:3043 1987, and the basic system of earthing shall be TNS.

6.2 EARTHING CONDUCTORS

Earthing conductors shall be of copper / GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

6.3 SIZING OF EARTHING CONDUCTORS

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80sq.mm. If the area of the largest current carrying conductor or busbar exceeds160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross-sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits up to 15 amps shall be earthed with PVC insulated copper wire.

6.4 CONNECTION OF EARTHING CONDUCTORS

Main earthing conductors shall be taken from the earth connections at the main LT panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured ineffective electrical contact with a run of metallic conduit shall not be considered as apart of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed. The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class quality and neat workmanship. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with earthing strip welded to grid and bolted at equipment ends.
6.5 PROHIBITED CONNECTIONS

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or in flammable liquid, structural steelwork, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm.

The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

6.6 EARTHING

The following must always be ensured in earthing system.

- All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.

- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

6.7 The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

6.8 RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 1 ohm.

6.9 SPECIFICATION FOR HOT DIP GALVANIZING PROCESS: GENERAL REQUIREMENTS

6.9.1 Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

6.9.2 Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm. The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters. Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then...
galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

6.10 EARTHING ELECTRODE

Maintenance free Earthing Electrode System/ Chemical Earthing

In maintenance free earthing with copper/GI pipe shall be as define in Boq and 3 meter length. The pipe shall be placed in a 150 mm dia an augured hole in the ground and then surrounded by ground enhancement material in either a dry form or pre mixed in a slurry. Once set, ground enhancement material becomes hard and as such holds positively to the rod as well as surrounding ground.

Earth pipe offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core (Design feature that prevents the ingress of moister and subsequently the integrity of the rod.

Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.

Ground enhancement material shall be as per IEEE-80 clause 9.5d with a resistivity of less than 0.12 ohm-meter. The ground enhancement material shall be permanent and not leach any chemicals in to the ground. The pH value of the ground enhancement material shall be 6.9 to 7.2 of 100 gm/ lit @ 20 deg.C.

Minimum 30 Kg of ground enhancement material shall provide for each earth electrode.

Inspection chamber shall be of DMC Pit Cover of 450mm dia. 2 Nos. of 50 x 6 mm cross section & 300 mm long copper strip to be clamped with copper claded rod electrode have sufficient nos (But not less than 4 Nos.) of 10sq mm GI nuts & bolts for connection to the equipment / interconnection to the other pits to form equi-potential bonding.

6.11 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by addition of calcium chloride, sodium carbonates copper sulphate, salt and soft coke or charcoal in suitable proportions.

The resistance of earthing system shall not exceed 1 ohm. Earthing clamps for supporting earth strips shall be of such design so as to avoid bimetallic action between strip and clamps.

After the installation of strips the wall slab or floor etc. should be finished to the satisfaction of the client.

7. LIGHTNING PROTECTION SYSTEM

7.1 SCOPE OF WORK
The work to be done under this section comprises the supply & installation necessary for the complete installation of the lightning protection system. The design of the components shall be traceable to field research, laboratory testing, fundamental analysis, and statistical levels of the lightning event.

The design of the components shall be traceable to long term practical field studies laboratory testing, fundamental scientific principles and statistical levels of the lightning event as documented in international standard.

The lightning protection system should comply in accordance with IS/IEC 62305-3:2010 standard and shall be installed strictly to the manufacturer’s instructions. The lightning protection system shall include components as follows:

Air terminal
Mechanical supports
Strip on roof and periphery
Down-conductors
Underground periphery
A low impedance grounding system.

7.2 STANDARDS

Complete installation shall be engineering and constructed in accordance with the latest revision of the following:

IS/IEC 62305-3:2010: Protection against lighting-part-3: physical damage to structure and life hazard.

IEC 60364-5-54: Low Voltage Installation part 5-54: Selection and erection of electrical system earthing arrangement, protective bonding conductor.


NEC SP30:2011: National electric code.

UL467 Grounding and Bonding equipment.

The details of the lightning protection system shall also confirm to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

7.3 AIR TERMINAL

Air termination intended to intercept lightning flash consisting of metal rod, metal mesh conductor.

Air termination system components installed on a structure shall be located at corner, exposed points and edges in accordance with angle/rolling/mesh methods as per given table.
<table>
<thead>
<tr>
<th>Protection Class</th>
<th>Rolling sphere method</th>
<th>Mesh Method</th>
<th>Protection Angle Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>radius of rolling spare R(m)</td>
<td>Mesh spacing W/m</td>
<td>Air terminal Height</td>
</tr>
<tr>
<td>I</td>
<td>20</td>
<td>5X5</td>
<td>20</td>
</tr>
<tr>
<td>II</td>
<td>30</td>
<td>10X10</td>
<td>30</td>
</tr>
<tr>
<td>III</td>
<td>45</td>
<td>15X15</td>
<td>45</td>
</tr>
<tr>
<td>IV</td>
<td>60</td>
<td>20X20</td>
<td>60</td>
</tr>
</tbody>
</table>

### 7.4 HORIZONTAL AND DOWN CONDUCTOR

The horizontal and down conductor should be used 25 x 3 mm GIstrip. The conductor shall be arranged in such a way that the length shall be minimum. Increasing of no of conductors can reduce dangerous electromagnetic effect of lighting current. A equal spacing of the down conductor is preferred around the perimeter of the building. Maximum distance between two down conductors in different lighting protection level shall be as below-

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Typical Distance (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>10</td>
</tr>
<tr>
<td>II</td>
<td>10</td>
</tr>
<tr>
<td>III</td>
<td>15</td>
</tr>
<tr>
<td>IV</td>
<td>20</td>
</tr>
</tbody>
</table>

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

### 7.5 LIGHTNING FLASH COUNTER
Each protection system shall be supplied with Lightning strike counter. The counter shall have a register that activates one count for every discharge where the peak current exceeds 400A at the 8/20us standard.

The lightning flash counter shall be robust and easy to install. The counter shall operate from the energy of the lightning discharge and should not work on external or battery power to operate.

The lightning flash counter shall be installed to the manufacturer’s instructions in a readily accessible manner (always 2mts above the Ground) so that reading can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -20°C to + 60°C.

7.6 GROUNDING SYSTEM

The Lightning arrester grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system.

Grounding will be done by copper bonded steel core ground rods especially designed for electrical grounding.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building to arriving services is recommended.

Electrically conductive, non soluble TEREC Powder should be used to achieve low ground resistance. Provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

8. AUXILIARY EQUIPMENT FOR SUB-STATION

8.1 Battery Charger Unit

i. General

The battery charger shall be Float cum Boost type Thyristor controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

ii. Construction Feature

Float cum Boost charger and DC Distribution Board shall be housed in sheet steel cubicle with panels of 1.6 mm thickness, louvers for ventilation glands plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens grey shade RAL-7032. The battery charger is divided into two compartments. The upper compartment houses the battery charger with all the necessary controls. The lower compartment is suitable for housing the batteries.

iii. Performance

The D.C output voltage of Float / Boost charger shall be stabilized within + 2% for AC input variation of 230 V + 10%, frequency variation of 50 Hz + 5% and DC load variation of 0-100%. The
voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

iv. Components

The battery charger shall essentially comprise of the following

1 No. double pole ON/OFF MCB at AC input.

1 No. pilot lamp to indicate charger ON.

1 No. Main Transformer: Double wound, naturally air cooled, having copper winding.

1 set single phase full wave bridge rectifier consisting of 2 Nos. diodes and 2 Nos. SCRs, liberally rated, mounted on heat sinks and complete with resistor / condenser network for surge suppression.

1 No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.

1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at + 2% of time set value for AC input voltage variation of 230 V + 10%, frequency variation of + 5% from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.

1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.

1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.

1 No. moving coil DC voltmeter to read the DC output voltage.

2 set potentiometer to adjust the output voltage during manual /auto float and boost modes.

1 No. double pole ON/OFF MCB for Charger Output (24 V DC Rating).

2 set DC output terminals. 1 set for the load and the other set for the battery.

Alarm Annunciation : Visual and audible alarm with manual accept reset facility shall be provided for the following :

a. AC mains fail
b. Charger Fail
c. Load / Output overvolt.

Rating

**AC Input:** 230 V + 10% AC 50 Hz single phase.

**DC Output:** To float / boost charge 24 V / 200 AH batteries and supply a continuous load.

**Current Rating:** 30.0 Amps

**Float Mode:** 27.0 V nominal (Adjustable) between 24-28.0 V.

**Boost Mode:** 28.2 V nominal (Adjustable) between 24-29.0 V.

**Voltage Regulation:** + 2% for AC input variation of 230 V + 10%.
Frequency Variation of 50 Hz + 5% and DC load variation 0-100%

**Ripple:** Less than 5%

v. DC Distribution Board

It shall be provided in the charging cubicle, it will comprises of the following:

**Incoming:** 1 No. 63 A DP MCB

**Outgoing:** 10 Nos. 16 A DP MCB

8.2 Safety Equipment

**Danger Plate**

Danger plate shall be provided on HV and MV equipment. MV danger notice plate shall be 200 mm x 150 mm made of mild steel atleast 2 mm thick with vitreous enamelled white on both side and with inscription in red colour on front side.

**Fire Extinguishers**

Portable CO2 conforming to IS:2878-1976, and dry chemical conforming to IS:2171-1967 shall be provided in the Sub-station.

**Insulating Mats for Electrical Purpose**

**Materials:**

Insulating Mats shall be in compliance with IS-15652-2006 /IEC 61111-2002-06.

The insulating mats shall be made of Elastomer (a generic term that includes rubber, latex and elastomer compounds that may be natural or synthetic or a mixture of both) for use as floor covering for
the protection of workers on AC and DC installation with the system voltage upto 66 KV AC and 240 volts DC.

Classes and max. use voltages of insulation mats shall be as follows:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Class</th>
<th>AC (rms)</th>
<th>DC (volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>A</td>
<td>3.3</td>
<td>240</td>
</tr>
<tr>
<td>ii.</td>
<td>B</td>
<td>11</td>
<td>-</td>
</tr>
<tr>
<td>iii.</td>
<td>C</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>iv.</td>
<td>D</td>
<td>66</td>
<td>-</td>
</tr>
</tbody>
</table>

Mats shall be resistant to acid and oil and low temperatures and shall be identified by the respective class symbol.

Thickness of mats for different classes, physical properties, dielectric properties and all other specification shall be as per IS:15652-2006. be free from blisters, pin holes, cracks, embedded foreign matters and other defects.

9. EXTERNAL / STREET LIGHTING POLES

9.1 M.S. Tubular Poles

9.1.1 7 Meter High Pole with Ladder Bars

7 meter high (5.75 meters above and 10.25 meters below ground shall be M.S. step tubular pole in 3 steps (bottom part shall be 4 meters high, 19.3 mm outer dia and 3.65 mm wall thickness, middle part shall be 10.5 meter high, 88.9 mm outer dia and 3.25 mm wall thickness, top part shall be 10.5 meters high, 76.1 mm outer dia and 3.25 mm wall thickness) with 300 mm x 300 mm x 6 mm thick base plate. Foundation for the pole shall be of cement concrete in 1:2:4 ratio. (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wire from the terminals block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

9.1.2 4.5 Meter High Pole

4.5 meter high (3.6 meter above and 0.9 meter below ground) shall be 75 mm dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base plate. Foundation for the pole shall be of cement concrete in 1:2:4 rates (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.
9.2 Cast Aluminium Poles

Design & Construction

Ornamental cast aluminum pole shall be made out of cast aluminum as per requirements of IS: 202 (1993). Casting of all pole Sections shall be accurately done from permanent moulds and cores of the design submitted to Achieve uniformity in all design aspects in internal and external shape of the unit. All sections shall be free from defects like blow holes, porosity, hard spots, cracks, Hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole shall be free from welding of any kind used to repair it. The casted sections shall be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts shall be maintained throughout a lot for random replacements of sections if and when required. All the threaded joints shall be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

Aesthetic appearance

All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

Material

Cast aluminum material used for casting pole unit shall be Grade FG-220 type, as described in IS:202 and shall have minimum tensile strength of the order of 200 N/mmsq.

Pre-treatment

Each and every casted piece shall be subject to Sand blasting at a pressure of 10-15 kgf to remove all its external dirt and sand remains etc..

Painting and Finishing

Entire unit shall be given an extensive three stage treatment with PU based two packZn-Ph primer and paint prescribed for Cl surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint shall be MRF make or equivalent.

Thickness of the coating

A minimum of 80 microns of coating thickness shall be achieved on the final piece.

Mounting arrangement

Pole unit shall be grouted using 4 nos. anchor bolts of size M-16x450 mm confirming to 6.8 Gr. as per IS 2062. Pole unit shall be grouted on a foundation made out of 1:3:6 concrete cement after excavating the earth with proper cable sleeves etc. laid in the foundation itself.

Dimensions of the unit

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total height</td>
<td>3000 mm</td>
</tr>
<tr>
<td>Dia of base plate</td>
<td>380 mm</td>
</tr>
</tbody>
</table>
Pitch Circle Dia = 335 mm

Description of top bracket / arms

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two nos. bolts outreach not less than 400 mm.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

9.3 Galvanized Octagonal Poles

Design

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS : 5649 Part VI 1982.

Pole Shaft

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.
Material

Octagonal Poles : HT Steel Conforming to grade S355JO
Base Plate : Fe 410 conforming to IS 226 / IS 2062
Foundation Bolts : EN.8 grade

Welding

The welding shall be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

Pole sections

The Octagonal Poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

Galvanization

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

Xing type

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mountings

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

Manufacturing

The pole manufacturing & galvanizing unit shall be ISO 9001 : 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided up to the service window. An earth boss is provided on the control plate along with connectors and interrupters.

Galvanized Octagonal Poles Dimensions
### Table:Foundation Bolt Details

<table>
<thead>
<tr>
<th>Height (mtr)</th>
<th>Top Dia (A/F)</th>
<th>Bottom Dia (A/F)</th>
<th>Sheet Thickness (mm)</th>
<th>Base Plate Dimensions (LxBxT)</th>
<th>Foundation Bolt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bolt Size (No. x Dia)</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>130</td>
<td>3</td>
<td>200 x 200 x 12</td>
<td>4 x 16 Dia</td>
</tr>
<tr>
<td>4</td>
<td>70</td>
<td>130</td>
<td>3</td>
<td>200 x 200 x 12</td>
<td>4 x 16 Dia</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>130</td>
<td>3</td>
<td>200 x 200 x 12</td>
<td>4 x 16 Dia</td>
</tr>
<tr>
<td>6</td>
<td>70</td>
<td>130</td>
<td>3</td>
<td>220 x 220 x 12</td>
<td>4 x 20 Dia</td>
</tr>
<tr>
<td>7</td>
<td>70</td>
<td>130</td>
<td>3</td>
<td>220 x 220 x 12</td>
<td>4 x 20 Dia</td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>135</td>
<td>3</td>
<td>225 x 225 x 16</td>
<td>4 x 20 Dia</td>
</tr>
<tr>
<td>9</td>
<td>70</td>
<td>155</td>
<td>3</td>
<td>260 x 260 x 16</td>
<td>4 x 24 Dia</td>
</tr>
<tr>
<td>10</td>
<td>70</td>
<td>175</td>
<td>3</td>
<td>275 x 275 x 16</td>
<td>4 x 24 Dia</td>
</tr>
<tr>
<td>11</td>
<td>90</td>
<td>210</td>
<td>3</td>
<td>300 x 300 x 20</td>
<td>4 x 24 Dia</td>
</tr>
<tr>
<td>12</td>
<td>90</td>
<td>240</td>
<td>3</td>
<td>320 x 320 x 20</td>
<td>4 x 24 Dia</td>
</tr>
</tbody>
</table>

### 10. CABLING FOR VOICE SYSTEM

#### 10.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous installation hardware and consumables to install a complete system. However, it is the responsibility of the vendor...
10.2 Applicable Documents

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

i. This Technical Specification and Associated Drawings


v. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

10.3 Backbone Wiring

General

The function of the backbone wiring shall be to provide interconnections between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system. The backbone wiring shall consist of the transmission media, intermediate and main cross connects, and mechanical terminations for interconnection of telecommunications closets, equipment rooms and entrance facilities. The backbone wiring shall include transmission media in the building.

The backbone wiring shall use the star topology wherein each telecommunications closet shall be wired to a main cross connect / patch panel or an intermediate cross connect then to a main cross-connects / patch panel. There shall be no more than two hierarchical levels of cross connects / patch panel in the backbone wiring. Interconnections between any two telecommunications closet shall pass through three or fewer cross-connects / patch panel.

Bridged taps shall not be permitted as part of the backbone wiring.

One of the following types of cables shall be used for backbone wiring as defined in schedule of quantities.

1. 100-ohm UTP multiplier backbone cable.

2. 50/125um-optical fiber cable.

The contractor has to assure that cross talk coupling between individual, unshielded twisted-pairs shall not affect the transmission performance of multi-pair cables.
10.4  Horizontal Wiring

General

The horizontal wiring shall be the portion of the telecommunications wiring system that will extend from the work area telecommunications outlet to the telecommunications closet. The horizontal wiring shall include the telecommunications outlet in the work area, mechanical termination for the horizontal cables, and cross-connections located in the telecommunications closet.

The horizontal wiring shall be capable of handling the following minimum services.

1. Voice telecommunications.
2. Premises switching equipment.

The horizontal wiring shall be a star topology with each work area telecommunications outlet connected to a telecommunications closet. Horizontal wiring shall preferably contain no more than one transition point between different forms of the same cable type.

Bridged taps shall not be permitted as part of the horizontal wiring.

The maximum horizontal distance shall be limited to 90 meters (295 ft) independent of media type i.e. the cable length from the mechanical terminating of the media in the telecommunications closet to the telecommunications outlet in the work area shall be limited to this distance. This horizontal distance includes cabling required from the telecommunications outlet to the workstation. Horizontal cable shall be limited to one of the following types as listed out in the schedule of quantities.

1. four-pair 100-ohm unshielded twisted pair (UP) cables.
2. 50/125 um-optical fiber cable.

Grounding Considerations

Grounding system shall be an integral part of the telecommunications wiring system. In addition to helping protect personnel and equipment from hazardous voltages, the grounding system shall reduce the effect of electromagnetic interference (EMI) to and from the telecommunications wiring system.

Grounding shall meet the NEC requirements and practices or local authorities or codes whichever impose a more stringent requirement.

The following shall be considered for the grounding system.

Installation conforms with proper practices and requirements.

Each telecommunications closet shall have an appropriate grounding access.
Grounding shall be available for cross-connect frames, patch panel racks, telephone and data equipment and equipment required for maintenance and testing.

10.5 Backbone Wiring Distances

Telecommunications Closet to Main Cross-Connect

The maximum backbone distance between the main cross-connect patch panel and the mechanical termination in the telecommunications closet shall be as follows:

For 50/125 ohms optical Fiber cable the distance between Telecommunication closet and main cross connect / patch panel shall not exceed 2000 mts.

For 100-ohm UTP cable, maximum distance between telecommunication closet and main cross connect / panel shall be 800 mts.

Telecommunications equipment which connect directly to main or intermediate cross-connects / patch panel shall done via cables of 30 m or less.

10.6 Telecommunications Closet

A telecommunications closet shall be defined as an area within the building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. There shall be no upper limit on the number of telecommunications closets, which may be provided within the building. The telecommunication closet shall have following three possible configurations.

Horizontal Backbone Connection

The telecommunications closet shall contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In such a case the telecom closet shall provide facilities (space, power, grounding etc.) for the passive (cross-connect) / patch panel or active devices or both used to interconnect the two system.

Backbone Wiring System Interconnection

The telecommunications closet may contain the intermediate cross-connect / patch panel or main cross connect / patch panel for different portions of the backbone wiring system. In this usage, the telecommunications closet shall provide facilities for the passive or active devices or both used to interconnect two or more portions or the backbone wiring system.

Entrance Facilities

A telecommunications closet may be used to contain the demarcation point or an underbuilding entrance facility. In this usage, the telecommunications closet shall provide facilities for the active and / or passive devised required to interconnect the demarcation point or underbuilding entrance facility or both to the telecommunication wiring system.

The design of the telecommunications closet shall be as per the requirements of EIA/TIA-569.

10.7 Equipment Room
The equipment room shall be defined as an area within the building where telecommunications systems shall be housed along with the mechanical termination of one or more portions of the telecommunications wiring system. Equipment room shall be considered to be distinct from telecommunications closets because of the nature or complexity of the equipment they contain. Any or all of the functions of a telecommunications closet shall be alternatively provided by an equipment room.

10.8 Cable Specifications

10.8.1 UTP Cabling System

10.8.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

<table>
<thead>
<tr>
<th>Networks Supported</th>
<th>10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warranty</td>
<td>25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs</td>
</tr>
<tr>
<td>Performance</td>
<td>Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel</td>
</tr>
<tr>
<td>characteristics</td>
<td>to be provided along with bid</td>
</tr>
</tbody>
</table>

10.8.1.2 Unshielded Twisted Pair, 0.5mm copper cable, TIA / EIA 568-B.2

<table>
<thead>
<tr>
<th>Material:</th>
<th>0.5mm solid bare copper or better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor:</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>Insulation:</td>
<td>Flame Retardant PVC</td>
</tr>
<tr>
<td>Jacket:</td>
<td>Cross-member fluted Spline.</td>
</tr>
<tr>
<td>Approvals:</td>
<td>UL Listed</td>
</tr>
<tr>
<td>ETL verified to TIA / EIA Cat 6</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-20 Deg. C to +60 Deg. C</td>
</tr>
<tr>
<td>Frequency tested up to</td>
<td>Minimum 600 MHz</td>
</tr>
<tr>
<td>Packing:</td>
<td>Box of 305 meters</td>
</tr>
<tr>
<td>Delay Skew:</td>
<td>45ns MAX.</td>
</tr>
<tr>
<td>Impedance:</td>
<td>100 Ohms + / - 15 ohms, 1 to 600 MHz</td>
</tr>
</tbody>
</table>
1. Performance characteristics to be provided along with bid are Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR.

10.9 0.5mm Riser Cable

This cable shall consist of solid copper conductors insulated with expanded polyethylene covered by a PVC sheet. The core shall be covered with a layer of plastic tape and overlaid with a corrugated PVC plastic. It shall be suitable to be used without conduit. The cable shall meet EIA/TIA -568, C S A T -529, IEEE 802.3 & 10 B A S E -T. The pair sizes shall be as per the schedule of quantities. The cable shall meet the following specifications.

a. Maximum DC Resistance 26.5 ohm per 100 ft.

b. Maximum DC Unbalanced Resistance 17%

c. Mutual Capacitance at 1 kHz 16 nF per 1000 ft.

10.10 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

11. CABLING FOR DATA SYSTEM

11.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting data and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

11.2 Applicable Documents
The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

a. This Technical Specification and Associated Drawings
d. ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993
e. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August 1994

11.3 Cabling System and Component Specifications

11.3.1 UTP Cabling System

11.3.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

Networks Supported: 10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet

Warranty: 25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs

Performance characteristics to be provided along with bid: Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel

11.3.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2

Material:

Conductors: 23 AWG solid bare copper or better

Insulation: Polyethylene

Jacket: Flame Retardant PVC
<table>
<thead>
<tr>
<th><strong>Pair Separator</strong></th>
<th>Cross-member fluted Spline.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approvals</strong></td>
<td>UL Listed</td>
</tr>
<tr>
<td></td>
<td>ETL verified to ANSI/TIA Cat 6</td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>-20 Deg. C to +60 Deg. C</td>
</tr>
<tr>
<td><strong>Frequency tested up to</strong></td>
<td>Minimum 250MHz</td>
</tr>
<tr>
<td><strong>Packing</strong></td>
<td>Box of 305 meter</td>
</tr>
<tr>
<td><strong>Delay Skew</strong></td>
<td>45ns MAX.</td>
</tr>
<tr>
<td><strong>Impedance</strong></td>
<td>100 Ohms + / - 15 ohms, 1 to 600 MHz.</td>
</tr>
<tr>
<td><strong>Performance characteristics to be provided along with bid</strong></td>
<td>Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR</td>
</tr>
</tbody>
</table>

**UTP Jacks**

<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th>PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568 A and B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Durability</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Modular Jack</strong></td>
<td>750 mating cycles</td>
</tr>
<tr>
<td><strong>Wire terminal</strong></td>
<td>200 termination cycles</td>
</tr>
<tr>
<td><strong>Accessories</strong></td>
<td>Strain relief and bend-limiting boot for cable Integrated hinged dust cover</td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Housing</strong></td>
<td>Polyphenylene oxide, 94V-0 rated</td>
</tr>
<tr>
<td><strong>Wiring blocks</strong></td>
<td>Polycarbonate, 94V-0 rated</td>
</tr>
<tr>
<td><strong>Jack contacts</strong></td>
<td>Phosphorous bronze, plated with 10.27 micro-meter thick gold</td>
</tr>
<tr>
<td>Feature</td>
<td>Specification</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Type</td>
<td>24-port, PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2</td>
</tr>
<tr>
<td>Ports</td>
<td>24</td>
</tr>
<tr>
<td>Port arrangement</td>
<td>Modules of 6-ports each, arranged 1port x 6.</td>
</tr>
<tr>
<td>Category</td>
<td>Category 6</td>
</tr>
<tr>
<td>Circuit Identification Scheme</td>
<td>Icons on each of 24-ports</td>
</tr>
<tr>
<td>Port Identification</td>
<td>9mm or 12mm Labels on each of 24-ports (to be included in supply)</td>
</tr>
<tr>
<td>Height</td>
<td>1 U (10.75 inches)</td>
</tr>
<tr>
<td>Durability</td>
<td>750 mating cycles</td>
</tr>
</tbody>
</table>

**UTP Jacks panel**

- **Approvals**: UL listed
- **Performance Characteristics to be provided with bid**: Attenuation, NEXT, PS NEXT, FEXT and Return Loss
Wire terminal (110 block) 200 termination cycles
Accessories Strain relief and bend limiting boot for cable
Materials
Housing Polyphenylene oxide, 94V-0 rated
Wiring blocks Polycarbonate, 94V-0 rated
Jack contacts Phosphorous bronze, plated with 10.27 micro-meter thick gold
Panel Black, powder coated steel
Approvals UL listed
Termination Pattern TIA / EIA 568 A and B;
Performance Characteristics to be provided along with bid Attenuation, NEXT, PS NEXT, FEXT and Return Loss

Faceplates
Type 1-port, White surface box
Material ABS / UL 94 V-0
No. of ports One

Workstation / Equipment Cords
Type Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2
Conductor 23 AWG 7 / 32, stranded copper
Length 7-feet
Plug Protection Matching colored snag-less, elastomer polyolefin boot
Warranty 25-year component warranty
Category Category 5
Plug
Housing Clear polycarbonate
Terminals Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate
Load bar PBT polyester
Jacket PVC
Insulation Flame Retardant Polyethylene

11.4 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

12. CABLING FOR TV SYSTEM

12.1 The Co-axial cable shall be of wide band type with operation capability up to 500 MHz

12.2 The ageing resistance of the co-axial cable shall comply with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz measured by artificial ageing (14 days at 80 deg. C)

12.3 Cables shall meet or exceed the following specifications.

<table>
<thead>
<tr>
<th>Construction</th>
<th>RG-6 MATV Type</th>
<th>RG-11 MATV Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Center Conductor</td>
<td>18 AWG tinned copper</td>
<td>14 AWG tinned copper</td>
</tr>
<tr>
<td>b Dielectric Foam Polyethylene</td>
<td>Nom. dia 0.180</td>
<td>Nom. dia 0.280</td>
</tr>
<tr>
<td>c Shield Foil - 0.003 Al. Tape</td>
<td>Braid - 34 AWG 4 end</td>
<td>AL 60% coverage dia 0.212</td>
</tr>
<tr>
<td></td>
<td>Braid - 34 AWG 6 end</td>
<td>AL 60% coverage dia 0.39.</td>
</tr>
<tr>
<td>d Jacket Black PVC flameretardant</td>
<td>Black PVC flame retardant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dia over jacket 0.272 +</td>
<td>over jacket 0.405 + 0.010</td>
</tr>
</tbody>
</table>
### Electrical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Dielectric Strength</td>
<td>Conductor to shield</td>
<td>Conductor to shield</td>
</tr>
<tr>
<td></td>
<td>2000 VDC</td>
<td>1500 VDC</td>
</tr>
<tr>
<td>b. Capacitance</td>
<td>10.2 PF / FT, Nom</td>
<td>10.2 PF / FT, Nom</td>
</tr>
<tr>
<td>c. Impedance</td>
<td>75.0 + 3.0 ohms</td>
<td>75.0 + 3.0 ohms</td>
</tr>
<tr>
<td>d. Attenuation</td>
<td>DB/100 ft.</td>
<td>DB/100 ft.</td>
</tr>
<tr>
<td></td>
<td>0.65 DB @ 5 MHZ</td>
<td>0.35 DB @ 5 MHZ</td>
</tr>
<tr>
<td></td>
<td>0.76 DB @ 10 MHZ</td>
<td>0.94 DB @ 50 MHZ</td>
</tr>
<tr>
<td></td>
<td>0.96 DB @ 20 MHZ</td>
<td>10.28 DB @ 100 MHZ</td>
</tr>
<tr>
<td></td>
<td>10.98 DB @ 100 MHZ</td>
<td>10.78 DB @ 200 MHZ</td>
</tr>
<tr>
<td></td>
<td>4.21 DB @ 450 MHZ</td>
<td>2.20 DB @ 300 MHZ</td>
</tr>
<tr>
<td></td>
<td>4.80 DB @ 550 MHZ</td>
<td>2.75 DB @ 450 MHZ</td>
</tr>
<tr>
<td></td>
<td>6.49 DB @ 1000 MHZ</td>
<td>4.30 DB @ 1000 MHZ</td>
</tr>
<tr>
<td>e. Velocity of propagation</td>
<td>82.0% Nom</td>
<td>82.0% Nom</td>
</tr>
<tr>
<td>f. DCR</td>
<td>35.47 ohms / 1000 ft.</td>
<td>9.29 ohms / 10000 ft.</td>
</tr>
<tr>
<td>g. SRL</td>
<td>30 DB (10 MHz to 300 MHz) 20 DB (5 to 450 MHz)</td>
<td>20 DB (5 to 450 MHz)</td>
</tr>
</tbody>
</table>

#### 12.4 Directional Couplers

These shall be of Ultra Wideband type and of hybrid circuit design.

These shall have a near flat frequency response over the entire operating range.

These shall have aluminium cast housing for high frequency radiation resistance.

These shall have ‘F’ sockets for all input, output and branch ports.

The Tapoffs shall be available in one way, two way and four way configurations.

The splitters shall be available in two way, three way and four way configurations.

The Tapoffs shall be available in different tap values ranging from 11 dB, 15 dB, 20 dB, 25 dB and 30 dB.

These shall meet or exceed the following specifications:
A. Tap off Splitters

a. Tap Loss 11-30 dB --

b. Through Loss 0.5-4 dB 4.0 - 8.0 dB

c. Isolation > 22 dB > 22 dB

d. Screening factor > 50 dB > 50 dB

B. FIRE DETECTION & ALARM SYSTEM WITH VOICE EVACUATION SYSTEM AND PUBLIC ANNOUNCEMENT

1. GENERAL DESCRIPTION

The Fire Alarm System supplier shall furnish and install a fully integrated Fire Detection cum Voice Evacuation system.

It is proposed to have a single, unified and integrated Fire Alarm cum Voice Evacuation system to meet the Life Safety Standards defined in NFPA standards and NBC standards.

The Fire Alarm System shall consist of Smoke detectors, Heat Detectors, and combination detectors selected as per specific requirements of the area to be installed in, as well as various input / output modules.

It is proposed to have Fire Detection Panels distributed at various floors, in the LV shafts.

Distributed on the floors are also the Voice and Fire Fighter’s Telephone command Centers, in direct peer-to-peer network with the Fire Alarm Panels.

Every Staircase shall be provided with a Fire Fighter’s telephone station comprising of a Firefighters telephone and jack, and a cabinet to house the same securely.

Voice evacuation speakers to meet the sound pressure levels as decreed by NFPA 72, NFPA 101 shall be deployed in the entire complex. Exit sounders, which shall emit a distinct temporal sound signature to help occupant evacuate the floor shall be deployed at the Fire Exit Staircases.

Digital Voice amplifiers shall be deployed on floor levels as per the attached schematics.

Touch Screen Panels, which shall enable the Fire Fighters to have immediate first-hand information of any fire scenario, along with the facility to display auxiliary information which shall be programmed to facilitate firefighting, shall be deployed at the entrances to the individual sections of the building, as depicted in the Schematic.
In Conclusion, a Truly Peer to Peer network of intelligent nodes shall be deployed to ensure life safety of the occupant of the building, and shall be programmed to ensure the fastest detection and safe evacuation of the occupants.

The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.

The system shall be support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.

Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

2. SCOPE OF WORK

2.1 Intelligent reporting, microprocessor controlled fire detection cum Voice Evacuation system shall be installed in accordance with the specifications and drawings.

The basic system comprises of Main Addressable Intelligent fire alarm panels, Voice and Fire Fighters Telephone Command Systems, Network Repeaters, Touch Screen Displays, networked on a peer to peer network as the headend of the System.

The Low side of the System shall comprise of the initiating devices such as the smoke / Heat / Combination Sensors, Manual Pull Stations etc.
Notification Applicances shall include Hooter cum Strobes, Speakers and Speakercum Strobes, Flashers, Alarm Bells etc.

All the above components shall be connected by interconnecting flexible copper cables, FRLS, PVC grade, laid in Gi conduits, or Armoured Cable for physical protection.

The scope shall include laying of the cables described above, citing of the various components to the direction of the architects and consultants, networking and programming to achieve the desired functionality.

2.2 The system shall be designed such that each signaling line circuit (SLC) is limited to only 80% of its total capacity at initial installation.

a. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

b. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

c. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

d. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.

e. Notification Appliance Circuits (NAC) speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.

f. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.

g. Notification Appliance Circuits (NAC) speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

h. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.

i. Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.

j. Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.

k. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B (Style Y), or two Class A (Style Z) circuits.

l. Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the
associated digital message generator, and upon loss of that connection shall be capable of one of the following system responses:

i. The digital amplifier shall automatically broadcast the stored audio message.

ii. The digital amplifier shall switch to a mode where a local bus input on the digital amplifier will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for the purpose of providing an alternate means of initiating an emergency message during a communication fault condition.

iii. Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.

iv. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the AudioCommandCenter and up to seven (7) remote Fire Fighter’s Telephone locations simultaneously on a telephone riser.

v. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.

vi. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of at least 16 or 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

2.3 Basic System Functional Operation

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

a. The System Alarm LED shall flash.

b. A local piezo electric signal in the control panel shall sound.

c. The 640-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.

e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

f. The audio portion of the system shall sound the proper audio signal (consisting of tone, voice, or tone and voice) to the appropriate zones.

3. CODES AND STANDARDS

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.
A. Underwriters Laboratories Inc. (UL) - USA:

No. 50      Cabinets and Boxes
No. 268     Smoke Detectors for Fire Protective Signaling Systems
No. 864     Control Units for Fire Protective Signaling Systems
No. 268A    Smoke Detectors for Duct Applications.
No. 521     Heat Detectors for Fire Protective
No. 228     Door Closers-Holders for Fire Protective Signaling Systems.
No. 464     Audible Signaling Appliances.
No. 38      Manually Actuated Signaling Boxes.
No. 346     Water flow Indicators for Fire Protective Signaling Systems.
No. 1481    Power supplies for Fire Protective Signaling Systems.
No. 1076    Control Units for Burglar Alarm Proprietary Protective Signaling Systems.

NFPA CODE 70 (NEC)
NFPA 72 Fire Alarm Code
NFPA 101 Life Safety Code


C. All requirements of the Authority Having Jurisdiction (AHJ).

3.1 APPROVALS

3.1.1 The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc. / FM Factory Mutual

3.1.2 The Fire Alarm Control Panel and all transponders shall meet the modular listing requirements of Underwriters Laboratories, Inc.

3.1.3 Each sub-assembly, including all printed circuits, shall include the appropriate UL modular label.

3.1.4 This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades, and are not acceptable.

4. PRODUCT / MATERIAL SPECIFICATIONS

4.1 General
This section of the specification includes the furnishing, installation, and connection of a microprocessor controlled, analog addressable, intelligent fire alarm equipment required to form a complete coordinated system ready for operation.

It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

The panel shall further extend fire and fault outputs, and on line data of status of all components, to the BMS for critical alarm monitoring, and it shall be possible to connect a interface card for open Protocol based (Commonly Bacnet Over IP, Modbus or eqv.) output to enable a software level integration with the BMS System.

The Panel shall be with integral voice evacuation cum Fire Fighters telephone system to relay evacuation messages in case of a fire emergency.

Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Central Monitoring Stations (Fire Command Center Room) and designated personnel, and if required, in other buildings at the site via a multiplex communication network.

The system shall also support independent gas release circuits for activation of various Fire Suppression systems, as required.

The system shall include hardware, modules to facilitate cross zoning of specific sensors, abort release functions, time delay and inputs for pressure switch and 24V output for Output operations.

The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

The main panel is to be located in the BMS Room on the Lower Basement Floor. All the other panels shall be distributed throughout the building complex, and shall be of multiple loops to accommodate all the sensors and devices with the spare loop capacity of 20% on every loop.

All the sensors and devices are connected to floor panels and all output circuits are activated from the same.

The Hooters cum Strobes / Speaker Strobes (Refer layout plans) are located at strategic locations to ensure audible alarm and voice messages reach every corner of the floor.

The panel shall be capable to zone all the sensors and devices and shall be able to activate outputs against activation of zone.

Wherever Applicable, The sensors located in Server Room shall be programmed in 2 separate zones per room to facilitate cross zoning, time delay and output to Gas Release system Panel in these rooms.

The panels shall be supplied with UPS power 230V AC and shall have its in-built battery backup and battery charger for 24 hours of standby operation, and the system shall be able to function for 30 minutes in full Alarm Condition, even during a Power Failure.

4.2 Basic Performance:
Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC).

Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.

On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

The System Alarm LED shall flash.

A local piezo electric signal in the control panel shall sound.

The LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

The audio portion of the system shall sound the proper signal (tone or voice) to the appropriate zones.

The fire alarm system shall detect all changes in status of monitored points and shall initiate appropriate acts to alert/evacuate occupants, provide event annunciation and activate auxiliary controls as specified herein.

The system shall accept process and evaluate the following types of input signals:

Automatic Fire Detectors

Manual Alarms

Supervisory (Tamper ) Condition

Trouble

The system shall store a record of alarm, supervisory and trouble events in non-volatile history file. This file shall contain the most recent 1000 events, with time and date of each event which consists of the 1000 most recent alarm events from the 5000 event history file. It shall be possible to select the number of events to be viewed in the history file by date, so the entire file does not have to be downloaded. The history file shall remain intact in the event of a loss of AC and battery power.

The system shall be capable of being expanded and field reprogrammed at any time up to the predetermined maximum capacity of the system, without the requirement to return the operating
system to the factory for program changes. All field programming shall be done by an authorized manufacturer's representative.

Intelligent, Analog and Addressable input devices shall receive power and communication protocol signals over a single pair of wires per channel (SLC) from the control unit.

Each channel (SLC) shall support Minimum of 159 analog and/or addressable devices. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address.

Channels shall be field programmable for NFPA 72(1993) Style 4 and 6 operations, with capability for Style 7 when used with approved loop isolation units.

Photoelectric, Laser, Multi criteria, Beam detectors and Thermal detectors shall be of the Intelligent, analog addressable type, and shall provide dual level alarm and pre-alarm reporting. Pre-alarm shall serve as early warning of an impending alarm condition, and shall generate a trouble condition in the panel.

Each detector head shall incorporate a microprocessor which provides for distributed system intelligence. The micro shall provide full monitoring and control of the device with memory for storage of pre-set sensitivity levels and other detection device parameters. For security purposes and system integrity no mechanical addressing switches shall be allowed for field devices. All setting of device parameter shall be done electronically.

System Power shall be adequate to accommodate all connected addressable and analog input devices in alarm simultaneously and shall be capable of operating all connected addressable output relays while all addressable inputs are in alarm. Prior to owner / contractor acceptance of installed system, manufacturer or his representative shall demonstrate 100% system alarm status with no loss of performance.

Activation of any manual alarm station or any other approved alarm initiating device (excluding Automatic Fire Detectors which will be described later) shall immediately result in the following:

Display the alarm condition on the LCD Displays of all the Peer-to-Peer networked Panels, Network Repeaters and Slave Repeaters, Touch Screen Displays.

Visual alarm signals shall be provided as indicated on the plans.

System shall shutdown/redirect all HVAC system fans, dampers, etc.; close fire doors, recall elevators, etc., in accordance with the schedule provided and with appropriate local/national code.

Operation of the system alarm silence switch shall silence all alarm audible connected to the system, with the exception of circuits programmed for the non-silence water flow feature. When properly configured, a silence command shall not extinguish visual alarm appliances. Circuits containing alarm visual circuits shall not be silenceable except upon system reset.

The system alarm LED and all other associated alarm displays shall remain illuminated until the alarm condition has been corrected and the panel has been reset.

A connected system printer (if supplied) shall record all the status changes that take place within the fire protection system, including alarm / trouble restoration. All status changes shall be logged.
The activation of an Automatic Fire Detector shall provide for all operations.

Alarm Verification per device in accordance with NFPA 72 - 1993 and UL 864.

Positive Alarm Sequence in accordance with NFPA 72 -1993 and UL 864.

Analog-Addressable smoke detectors shall be equipped with a Day/Night Sensitivity Mode which may be selected by either manual or automatic input.

Because certain smoke detector environments change from day (occupied) to night (unoccupied), a more sensitive or Night setting may be desirable. Adjustable sensitivity smoke detector values shall be distinctly identified in the system memory and by display.

Supervisory conditions shall cause a distinct annunciation at the panel. The system printer shall record supervisory events in a manner consistent for all status changes.

The fire alarm panel shall fully supervise its operation. The physical opening or cutting of the wiring to any initiation, alarm indicating, signaling line, or associated supervisory monitoring circuit shall cause distinct annunciation via the LCD display.

Analogue signals from detectors shall be processed in such a way as to discriminate, as far as possible, between sources of fire and false alarms, and shall identify detectors that are becoming dirty. As a minimum, multi-state indications, i.e. normal, fire, fault and pre-alarm warning, shall be provided for each detector.

It shall be possible to interrogate detectors to determine their analogue values and display these on the alphanumeric display of each control panel. There shall be the facility to display an individual detector’s value separately as well as values of all detectors together. It shall also be possible to set a value and display the addresses of all those detectors with values above that value.

The controlling software of the system shall be configured to group detectors and manual call points into zones.

Output signals, for example, to sounder circuits and interfaces, corresponding to individual device inputs and/or their related zones, shall be configurable in the controlling software of the system. They shall be freely assignable; i.e. each input shall be capable of being programmed to operate any, some, or all outputs.

The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point

It shall be possible to modify the configuration of zones and reconfigure the relationship between inputs and outputs. This shall be site programmable.

The system shall be immune to EMC-related interference. In particular, the Contractor shall take into account the use of VHF/UHF radio communication systems, mobile telephones, pagers and computers, and other electrical equipment used in the building.

The system shall be installed in accordance with the manufacturer’s instructions. In particular, the Contractor shall take due note of, and shall comply with, the manufacturer’s instructions on circuit design, minimum signal strengths, loadings and end-of-line terminations, where appropriate.
4.3 Wiring Arrangements

It shall be the responsibility of the Contractor to determine the number of loops and other circuits required for the system.

Where the system is distributed, the network linking the control panels shall be capable of being extended in the future to link to further compatible control panels. The capacity of the network shall be expandable by 25%.

4.4 Circuit Design

The control panel shall be capable of expansion via up to 10 SLC loops. Each module shall support up to 300 analog/addressable devices for a maximum system capacity of 3000 points.

Each detection loop shall originate and terminate at the control and indicating equipment.

The number of loops required for the system shall be determined on the basis of device capacity, total loop length and the area of coverage of each loop. The maximum area coverage per loop shall not exceed 10,000m².

Each loop shall incorporate a minimum of 25% spare device capacity for possible future use. The spare capacity shall relate to manual call points, detectors, sounder and beacons (where relevant) and loop interfaces in any combination.

All wiring shall be monitored for faults.

Loop wiring shall tolerate a single open-circuit fault without affecting any device on the same loop. Loop wiring shall also tolerate multiple open-circuits or short-circuit faults in one area, without affecting the devices in any other area or on any other loop or circuit.

Removal of a device from a loop shall not cause any remaining devices in the system to become inoperative.

It shall be possible to disable detectors on the system. The controlling software shall permit individual detector disablement and detector group disablement. As a minimum, a group shall correspond with the detectors in a particular zone. Group detector disablement shall not render manual call points in the same area inoperative.

Short-circuit isolators shall be provided at the beginning and end of each loop. Also, a single short circuit or open-circuit fault on an automatic fire detector circuit shall neither disable protection within an area of more than 2,000m², nor on more than one floor of the building plus a maximum of five devices (automatic detection, manual call points, sounders or a combination of these) on the floor immediately above and five devices on the floor immediately below that floor.

Where the system is distributed, the network between control panels shall be configured as a loop and shall be capable of tolerating a single open- or short-circuit without loss of communication between panels. It shall be a ‘peer to peer’ network that is not wholly dependent on a single, centralized processor or panel. In the event of failure of the network, each control panel on the network shall be capable of operating in a ‘stand-alone’ mode and thus generating fire alarm warnings in response to activation of a device connected to it.

4.5 False Alarms
Great care shall be taken, at the design stage, to minimize the likelihood of false alarms occurring in the new or modified system.

Devices shall be of types appropriate to the local environment. For example, optical smoke detectors shall not be installed in areas where there is likely to be steam or dust present. Also, manual call points shall be fitted with transparent hinged covers where there is the possibility of accidental operation, e.g. in kitchens or service areas.

4.6 SYSTEM COMPONENTS

4.6.1 System Architecture

The system shall have a centralized structure. The locations of control and indicating equipment shall be as shown on the Contract Drawings.

A centralized system has one set of control and indicating equipment in a single location in the building. (The control panel may also be connected to repeater or mimic panel(s) elsewhere in the building.) This means that all detection loop wiring, and separate sounders wiring (if appropriate) will emanate from the centrally located control and indicating equipment. Centralized systems are suitable where the lengths of loop and sounder cables do not become excessive because of the size of the building.

4.6.2 Main Components

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

4.6.3 CABLING

All fire alarm system wiring must be as specified here in.

Wiring shall be in accordance with local, state and national codes (NBC of India, IS 2189, NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 1.5 Sq. mm for initiating device circuits and signaling line circuits, for notification appliance circuits.

The Cables used shall be annealed tinned copper conductor XLPE / Elastomeric Insulted insulated FRLS armoured cable with Copper conductor having cross-linkable halogen free Ethylene Propylene Rubber (EPR) insulation and LSZH inner & outer sheath. Basic design as per BS 7846, IEC-502, IEC-
61034. Fire performance tests as per BS 8491:2008 Cat.3 (120 mins) for above 20 mm overall dia & for below 20 mm overall dia as per BS 6387 C.W.Z. & BS EN 50200 PH-120 + Annex-E. BRE GLOBAL / LPCB certified.

4.6.4 FIRE ALARM CONTROL PANEL OR NETWORK NODE

The main FACP Central Console shall be suitable to accommodate required number of devices having 1 Loop as spare for detectors & devices as well. It shall contain a microprocessor based Central Processing Unit (CPU).

The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

A network control annunciator shall be provided to display all system intelligent points. The NCA shall be capable of displaying all information for 200,000 points on the network. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.

In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator’s terminals, panel display, and annunciators.

When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system alarm LED shall flash.

A local piezo-electric audible device in the control panel shall sound a distinctive signal.

The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

Printing and history storage equipment shall log and print the event information along with a time and date stamp.
All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system trouble LED shall flash.

A local piezo-electric audible device in the control panel shall sound a distinctive signal.

The LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

Printing and history storage equipment shall log and print the event information along with a time and date stamp.

All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system trouble LED shall flash.

A local piezo-electric audible device in the control panel shall sound a distinctive signal.

The LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.

Printing and history storage equipment shall log and print the event information along with a time and date stamp.

All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system security LED shall flash.

A local piezo-electric audible device in the control panel shall sound a distinctive signal.

The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

Printing and history storage equipment shall log and print the event information along with a time and date stamp.

All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system pre-alarm LED shall flash.

A local piezo-electric audible device in the control panel shall sound a distinctive signal.

The backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

Printing and history storage equipment shall log and print the event information along with a time and date stamp.

All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

4.6.5 Operator Control

4.6.5.1 Acknowledge Switch:

Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.

Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

Signal Silence Switch: Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully fielded programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

4.6.5.2 Drill Switch

Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4.6.5.3 System Reset Switch

Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

4.6.5.4 Lamp Test
The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

4.6.5.5 Scroll Display Keys

There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

4.5.5.6 Print Screen

Depression of the PRINT SCREEN switch shall send the information currently displayed on the display to the printer.

4.6 System Capacity and General Operation

4.6.1 The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a maximum of 318 analog/addressable devices for a maximum system capacity of 3180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices and shall support up to 96 panel circuits which may consist of either inputs or outputs.

4.6.2 The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.

4.6.3 All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

4.6.4 The FACP shall be able to provide the following software and hardware features:

Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.

Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.
The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.

NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.

Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.

Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.

The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID’s and associate that ID with the corresponding address of the device.

Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or “drill”. If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.

Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions.

Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre alarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunciators, releasing zones, spal zones, and trouble zones.

Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.

Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.

Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

Tracking/Latching Duct (ion and photo): The system shall support both tracking and latching duct detectors either ion or photo types.

ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.
Security Monitor Points: The system shall provide means to monitor any point as a type security.

One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

Control by Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point’s zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device’s zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zones with four abort options to satisfy any local jurisdiction requirements.

Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall
also be possible to set a maximum verification count between 0 and 20 with the “0” setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

4.6.5 Central Processing Unit

The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.

The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.

Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.

The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.

The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

The CPU shall provide one high-speed serial connection for support of network communication modules.

The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

4.6.6 Display

The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

These characters shall be only for fire alarm / trouble information and not for Logo or other purpose. It shall be UL Listed. Repeater panel displays in FACP is not allowed unless until approved by UL.

The system display shall provide a 600-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.

The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 2 X 40-character LCD.

4.6.7 Loop (Signaling Line Circuit) Control Module

The control panel shall be capable of expansion via up to 10 SLC loops. Each module shall support up to 300 analog/addressable devices for a maximum system capacity of 3000 points.

The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.

The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit. Each Loop shall be capable of operating as a NFPA Class B circuit in case of single open circuit fault in existing SLC Circuit Fault isolation modules shall be installed between each addressable SLC device per the manufacturers installation instructions. Systems which cannot provide full loop loading in Style 7 configurations are not acceptable.

The SLC interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition.
The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

**Network Communication**

The FACP shall communicate over a peer-to-peer communication network, inherently over a regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 Control Panels / Network Nodes, over a single medium (copper conductor / fiber optic), redundant ring, communication channel for fire alarm, voice evacuation and telephone talk-back system. The system shall support up to 200 such networks in a single system. The network card shall have inbuilt Fiber port for terminating Fiber Optic Cable without any third party converters.

4.6.8 Enclosures

The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer’s standard finish.

The back box and door shall be constructed of 0.060 steel with provisions for electrical cables connections into the sides and top.

The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

4.6.9 Power Supply:

a. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.

b. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

c. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.

d. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

e. The Addressable Main Power Supply shall be power-limited per UL864 requirements.

4.6.10 Auxiliary Field Power Supply - Addressable
a. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.

b. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary powers for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.

c. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Classes "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.

d. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.

e. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.

f. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.

g. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

h. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.

i. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.

j. The addressable power supply mounts in either the FACP back box or its own dedicated surface mounted back box with cover.

k. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

l. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-
line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

m. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.

n. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

o. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

p. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

4.6.11 Field Charging Power Supply (FCPS)

The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

a. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.

b. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.

c. The FCPS shall include an attractive surface mountbackbox.

d. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.

e. The FCPS include power limited circuitry, per 1995 UL standards.

4.6.12 System Circuit Supervision

a. The FACP shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communication with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.

b. Transponders that lose communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.

c. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.
d. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual ON/OFF indication (green LED).

4.6.13 Field Wiring Terminal Blocks

All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

4.6.14 240W/250W Analogue Amplifier

The audio amplifier shall include an integral power supply.

Related output power – 240W/250W

Main Power supply Voltage – AC 220V -15% ~ +10% 50~60Hz

Backup Power Supply Voltage – AC 220V -15% ~ +10% 50~60Hz

Main Power supply fuse T10AL 250V

Loudspeaker Output – 100V/70V

Frequency Response – 70 ~ 15 KHz (+1dB~ -3dB)

SNR 90dB

4.6.15:

The Speaker appliance shall be listed to UL 1480 for Fire Protective Signaling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.

6W Ceiling/Wall Mounted Speaker

6W ceiling speaker with Max SPL1M/1W 96dB. Frequency response of 80Hz-20KHz with dispersion angle of 160deg. The speaker should have tappings at 6W/3W/1.5W

Max Power 9W

Rated Power 6 W

Power taps @ 100V – 6W/3W/1.5W

Sound pressure level at 6W/1W (4KHz, 1m) – 90dB /88dB

Frequency Range -20Hz -20 KHz

Dispersion angle (1KHz /-6dB) - 160°

Related Input Voltage – 100 V /70V
Rated impedance Connection 1.7Ω / 3.3 kΩ

Dimensions (Ø x H) - Ø180 mm x 55 mm

Hole cut-out size 150mm

Size of speaker – 5”

Colour – White (RAL 9010)

Weight of Magnet – 117g

4.6.16 Armoured 2 Core Cable

Continuous length of 2 Core ,

1.5 sq. mm dia strip

Armoured, PVC insulated ,

PVC Sheathed Cable

4.6.17 Audio Message Generator (Prerecorded Voice)/Speaker Control:

a. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.

b. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.

c. A built-in microphone shall be provided to allow paging through speaker circuits.

d. System paging from emergency telephone circuits shall be supported.

e. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:

   LED Indicators:
   - Lamp Test
   - Trouble
   - Off-Line Trouble
   - Microphone Trouble
   - Phone Trouble
   - Busy/Wait
   - Page Inhibited
   - Pre/Post Announcement Tone
4.6.18 Controls with associated LED Indicators:

a. Speaker Switches/Indicators
   i. The speaker circuit control switches/indicators shall include visual indication of active and
      trouble status for each speaker circuit in the system.
   ii. The speaker circuit control panel shall include switches to manually activate or deactivate each
       speaker circuit in the system.

b. Emergency Two-Way Telephone Control Switches/Indicators
   i. The emergency telephone circuit control panel shall include visual indication of active and
      trouble status for each telephone circuit in the system.
   ii. The telephone circuit control panel shall include switches to manually activate or deactivate
       each telephone circuit in the system.

4.6.19 Remote Transmissions:

   s. Provide local energy or polarity reversal or trip circuits as required.
   b. The system shall be capable of operating a polarity reversal or local energy or fire alarm
      transmitter for automatically transmitting fire information to the fire department.
   c. Provide capability and equipment for transmission of zone alarm and trouble signals to remote
      operator's terminals, system printers and annunciators.
   d. Transmitters shall be compatible with the systems and equipment they are connected to such as
      timing, operation and other required features.

4.6.20 System Expansion

Design the main FACP and transponders so that the system can be expanded in the future (to include
the addition of twenty percent more circuits or zones) without disruption or replacement of the existing
control panel. This shall include hardware capacity, software capacity and cabinet space.

4.6.21 Field Programming

The system shall be programmable, configurable and expandable in the field without the need for
special tools, laptop computers, or other electronic interface equipment. There shall be no firmware
changes required to field modify the system time, point information, equations, or annunciator
programming/information.

It shall be possible to program through the standard FACP keyboard all system functions.

All field defined programs shall be stored in non-volatile memory.

Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be
used for status level changes such as point/zone disable or manual on/off commands (Building
Manager). A second (higher-level) shall be used for actual change of the life safety program (installer).
These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third
time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.

The system programming shall be "backed" up on a 3.5" floppy diskette utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

4.6.22 Specific System Operations

Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.

Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or any time after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

System Point Operations –

Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.

System output points shall be capable of being turned on or off from the system keypad or the video terminal.

Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

DeviceStatus.

Device Type.

Custom Device Label.

Software Zone Label.

Device Zone Assignments.

Analog Detector Sensitivity.
All Program Parameters.

System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:

System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.

The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

4.7 Addressable Devices

Addressable devices shall provide an address-setting means using rotary decimal switches / Soft Programming.

Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.

Detectors shall be analog and Addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.

Addressable smoke and thermal detectors shall provide dual (2)status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
The detectors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature.

The following bases and auxiliary functions shall be available:

Sounder base rated at 85 DBA minimum.

FORM-C Relay base rated 30VDC, 2.0A

4.7.1 Isolator base

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

4.7.2 Manual Call Points

• The Manual call points(MCP) used in the building shall confine to the relevant standard shaving the following features

  • Manual call points shall be of Double action - break glass type with Push Button.
  
  • The mounted arrangement shall be such that it can be either surface mounted or flush mounted
  
  • Each addressable MCP will comprise of an electronic circuit built in to it to provide addressing capability.

  • The MCPs shall be provided with inbuilt fault isolator. (The bidder shall consider an external isolator if not inbuilt)

  • The MCP shall have a LED to indicate Alarms

  • The MCP shall be UL&FM approved list

4.7.3 Intelligent Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

The detector shall not respond to refrigerant gas.

4.7.4 Intelligent Self Acclimatising Multi Sensor Detector

The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
The intelligent multi sensor detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

The detector shall not respond to refrigerant gas.

4.7.5 Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

4.7.6 Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.

2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

4.7.7 Addressable Dry Contact Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.

The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
4.7.8 Addressable Control Module

Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

The control module shall mount in a standard 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box, or to a surface mounted back box.

The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.

The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

4.7.9 Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

The isolator module shall mount in a standard 4-inch (101.6 mm) deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

4.7.10 LCD Alphanumeric Display Annunciator:

The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of 160 characters for alarm annunciation in clear English text.

The LCD annunciator shall display all alarm and trouble conditions in the system.

Up to 32 LCD annunciators may be connected to an EIA 485 interface. LCD annunciators shall not reduce the annunciation or point capacity of the system. Each LCD shall include vital system wide functions such as, System Acknowledge, Silence and Reset.
LCD display annunciators shall mimic the main control panel displays and shall not require special programming.
The LCD annunciator shall have switches which may be programmed for System control such as, Global Acknowledge, Global Signal Silence and Global System Reset. These switch inputs shall be capable of being disabled permanently or by a key lockout function on the front plate.

4.7.11 Beam Detector

The System Sensor beam detectors are four wires conventional reflected beam smoke detectors. It shall be used with UL Listed compatible fire alarm control panels only. Installation of the single-ended reflective design is much quicker than a dual ended projected beam detector. Alignment is easily accomplished with an optical sight and a two-digit signal strength meter incorporated into the beam detector. Listed for operation from –22°F to 131°F. The beam detectors are a transmitter/receiver unit and a reflector. When smoke enters the area between the unit and the reflector, it causes a reduction in the signal strength. When the smoke level (signal strength) reaches the predetermined threshold, an alarm is activated. The detectors have four standard sensitivity selections as well as two Acclimate® settings. When either Acclimate® setting is selected, the detector will automatically adjust its sensitivity using advanced software algorithms to select the optimum sensitivity for the specific environment. The beam detector has an integral sensitivity test feature of a filter attached to a servomotor inside the detector optics. And The Beam Detector shall have a range upto 100 mtrs. There shall be multiple sensitivity levels. Starting from 25 %, 30 %, 40 %, 50 % and acclimate levels also 30 % to 50 % and 40 % to 50 %. There shall be trouble alarm if obscuration block is more than 96 %.

Features

Transmitter/receiver built into same unit.

Six user-selectable sensitivity levels.

16’ to 328’ protection range.

Removable plug-in terminal blocks.

Digital display for easy alignment.

Built-in automatic gain control compensates for signal deterioration from dust buildup.

Paintable cover.

Optional remote test station.

Optional long-range kit for applications in excess of 230’ (70 m).

Optional multi-mount kit providing ceiling or wall mounts capability with increased angular adjustment.

Optional heater kits for prevention of condensation Optional heavy-duty mounting bracket

Serially Connected Annunciator Requirements

1. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. EIA-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.
2. An EIA-485 repeater shall be available to extend the EIA-485 wire distance in 3,000 ft.
increments. An optional version shall allow the EIA-485 circuit to be transmitted over Fiber optics. The
repeater shall be UL864 approved.

3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life
programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm
Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local
acknowledge and lamp test switch, and custom zone/function identification labels.

4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When
configured as "Fan Control," the annunciator may be used to manually control fan or damper operation
and can be set to override automatic commands to all fans/dampers programmed to the annunciator.

5. Annunciator switches may be programmed for System control such as, Global Acknowledge,
Global Signal Silence, Global System Reset, and on/off control of any control point in the system.

6. An optional module shall be available to utilize annunciator points to drive EIA-485 driven relays.
This shall extend the system point capacity by 3,072 remote contacts.

7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of
the features listed above.

4.7.12 Battery

Shall be 12 volt, Lead Acid Maintenance free type.

Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours
plus 30 minutes of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling,
spills and leakage shall not be required.

4.7.13 Battery Charger

Shall be completely automatic, with constant potential charger maintaining the battery fully charged
under all service conditions. Charger shall operate from a 240-volt 50/60 hertz source.

Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously
supplying any loads connected to the battery.

Shall have protection to prevent discharge through the charger.

Shall have protection for overloads and short circuits on both AC and DC sides.

4.7.14 Addressable Relay Module:

Addressable Relay Modules shall be available for HVAC control and other building functions. The relay
shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0Amps inductive. The relay coil shall
be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all
auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4.7.15 Sounder (Hooter) Cum Strobe:

The Sounder used in this Building shall confine to the relevant standards having the following features:

- The Sounder shall be an Addressable sounder. (Bidder shall consider external power supply, cable, conduits, modules required for activating externally powered sounder and include the costing as part of the item – Sounders)
- The Sounder shall have inbuilt fault isolator module. (Bidder shall consider external isolators if not inbuilt)
- The Sounder shall either be addressed by Dip switch or by the Panel.
- The Sounder shall be placed in the detection loop only and a separate loop or cables or sounders shall not be used.
- The sounder shall have a sound pressure level of 90dB and the volume shall be adjusted from the Fire Alarm Panel.
- The sounder shall be tested and maintained with ease from the FACP.
- The Volume levels for Testing and Drill shall be programmed as per site conditions.
- The Sounder shall be capable of either accommodating a Flasher or a Detector and shall work as Sounder cum strobe or Sounder cum detector base.
- The Sounder shall have a feature of synchronizing with other sounders in the loop.

The Strobe used in this Building shall confine to the relevant standards having the following features:

- The Strobe shall have a red flash light and shall flash at minimum of 1Hz.
- The Strobe shall also be part of Testing and Drill and shall be programmed as per site conditions.
- The Strobe shall consume a minimal current of 10mA and thus allowing connecting at least 10 strobes in the same loop.
- The Strobe shall be capable of either fixing it in a Sounder and shall work as Sounder cum strobe as per site conditions.
- The Sounder cum strobe shall be UL&FM approved list.

4.7.16 Strobe lights:

- Shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
  1. The maximum pulse duration shall be 2/10 of one second.
  2. Strobe intensity shall meet the requirements of UL 1971.
  3. The flash rate shall meet the requirements of UL 1971.

4.7.17 Alphanumeric LCD Type Annunciator:
1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.

2. The LCD annunciator shall display all alarm and trouble conditions in the system.

3. An audible indication of alarm shall be integral to the alphanumeric display.

4. The display shall be UL listed for fire alarm application.

5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.

6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.

7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a keyswitch or password.

8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

4.7.18 Fixed Emergency Telephone Handset

1. The telephone cabinet shall be painted red and clearly labeled as "Emergency Telephone." The cabinets shall be located where shown on drawings.

2. The handset cradle shall have a switch connection so that lifting the handset off of the cradle shall send a signal to the fire command center, which shall audibly and visually indicate its on-line (off-hook) condition.

3. On activating the remote phone, the phone earpiece shall sound a telephone ring signal until the master handset is lifted.

4. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.

4.7.19 Interactive Touch Screen Display:

This specification includes the furnishing, installation, connection, and testing of an interactive firefighters' display; including Underwriters Laboratories (UL) listed application software and hardware complete and ready for operation. The basic system shall be Underwriters Laboratories (UL) listed for No. 864 Control Units or Fire Protective Signaling Systems (Ancillary listing).

An interactive firefighters' display shall be installed in accordance to the project specifications and drawings. The interactive firefighters' display system shall include, but not be limited to, a touch screen interface, network communications media, power supplies, and wire / fiber optic media as shown on the drawings and specified herein.
The interactive firefighters' display shall support fire alarm, supervisory, and security events from the fire alarm control panel(s). The interface shall display building floor plans with respective active fire alarm devices, water supplies, evacuation routes, access routes, gas, power and HVAC shutoffs, chemical hazards, and structural hazards in the building.

The system shall include an easy one-touch method of viewing building, emergency contacts, the facility site plan, and active event information. A supervised interface to fire alarm control panels and network shall be made available. The system shall be electrically supervised and monitor the integrity of all conductors.

4.7.20 Fire Fighter’s Display: Performance requirements

A. The network will interface and report the individually monitored system's alarm status via a user-friendly Graphical User Interface (GUI) based software.

B. The software shall operate under Microsoft® Windows® XP Embedded platform as manufactured by Microsoft Corporation.

C. The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations.

D. The software shall use a 1280 pixel x 1024 pixel GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.

E. The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.

F. The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.

G. The software shall display the activated smoke detectors in a time sequence to track smoke progression.

H. The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

I. The software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.

J. The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.

K. The software shall display "YOU ARE HERE" along with icons representing standard building objects (stairs, elevators, etc.) to be shown on the floor plan.

L. The software shall allow icons that represent hazardous materials stored in a facility.

M. The software shall provide a screen that displays preprogrammed building contact information.

N. The software shall provide a screen the displays building occupancy and other general building information.
O. The software shall allow a site plan to be imported that shows an aerial view of the facility.

P. The software shall display all active fire, supervisory, and security events within an event list.

Q. The system shall operate on an UL listed Embedded platform operating at no less than 700 MHz on the Microsoft® Windows® XP Embedded platform.

R. The Embedded platform shall have: no less than 256 megabytes of RAM, a flash drive with no less than 1 Gigabytes of storage space, 100 Base-T Ethernet NIC card, and USB ports.

S. The Embedded platform shall have a minimum 19" touchscreen display.

T. The Embedded platform shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment.

U. A UL listed Ethernet Hub shall be provided for connection of multiple interactive displays and/or gateways.

4.8 Monitoring Network

A. The monitoring network shall consist of a network based on proven ARCNET® technology.

B. The network shall have the ability to use fiber optic cable (single-mode and multi-mode), wire (twisted pair copper media in a style 4 or style 7 configuration), or combination wire/fiber communications with support of up to 103 nodes.

1. Wire networks shall support 12 AWG, 1 Pair Shielded to 24 AWG, 4 Pair Unshielded following the manufacturer's guidelines.

2. Fiber optic networks shall support 62.5/125µm cable 8dB limit (50/125µm cable 4.2dB limit)

3. Wire to fiber conversions using repeaters

C. High-speed data communications (312,500 BPS).

D. True peer-to-peer communications between fire alarm control panels.

4.9 Integration Network

A. The integration network shall be capable of monitoring a minimum of 100 nodes (Network Input/output Nodes and routers) on an integration gateway consisting of, but not limited to:

1. Intelligent or conventional fire alarm control panels.

2. Competitor's intelligent or conventional fire alarm control panels.

B. Up to 99 gateways shall be connected via Ethernet for a total local area combination of up to 12672 (99x128) nodes.

C. Local area networks shall consist of a free topology network using twisted pair copper media in a bus, star, T-tap, or ring style 7 configurations at 78 Kilo baud.
Transmit/receive twin fiber (multi-mode 62.5/125 µm) strand FT-10 point-to-point topology and bi-directional FO-10 networks shall also be available. Wide area networks shall be supported by the use of network expansion routers.

1. Free topology (FT-10 style) wire network run allows multiple T-taps within a 1,500-foot (457.2 m) radius; 8,000 foot (2438.4 m) point-to-point using twisted pair; or 6,000-foot (1828.8 m) bus topology.

2. Free topology (FT-10 style) fiber network can also use fiber-optic cabling. Operates at 78.5 Kbaud.

3. Fiber optic (FO-10 style) network allows bus or ring topology using only fiber-optic cabling; node-to-node distance of over 10,000 feet (3048 m) with message regeneration. FO-10 style operates at 1250 Kbaud and utilizes multi-mode bi-directional fiber media (single fiber strand) in a bus or loop configuration.

D. Provide routers, repeaters or bridges where required to increase distance, alter network configuration or change media or to extend to remote facilities over alternate communications media including UL listed dial-up PSTN telephone, leased line, multimode fiber or Ethernet connectivity.

1. Dial-up units shall dial a local number and stay connected. Upon loss of carrier, a supervisory alarm shall be indicated at the workstation and the units shall automatically redial to connect.

2. Network expansion routers shall support public switched telephone circuits, two-wire or four-wire leased lines, and CAT5 Ethernet networks.

E. Network interface software shall be by the same manufacturer as the hardware portion of this specification.

F. The integration network shall utilize Network Input / Output Nodes to interface between the individual buildings' systems to be monitored by the integration network. The Network Input/output Nodes shall act as a translator from the building system's specific panel communications protocol to the integration network protocol as well as serve as a transceiver from the building system panel to the integration network.

1. Network Input/Output Nodes shall be available in configurations that will allow transparent communications via RS 232 serial data ports with intelligent fire alarm control panels, security systems, and CCTV systems.

2. Network Input/OutputNodes shall be available in configurations that will allow monitoring of dry contacts, switched voltages, conventional security devices, access control panels and conventional fire alarm control panels using scheduled, automated and manual control.

3. Network Input/OutputNodes shall be UL listed to Standard 864 and 1076 and be provided with their own enclosure or be available in chassis mount configurations.

4. Network Input/OutputNodes shall operate at 24 VDC and obtain their power from the monitored control panel or a UL listed battery backed auxiliary power supply. All terminals shall be transient protected to 2400V and LEDs shall be provided for status, service and diagnostics.

G. Digital Alarm Communicator Receiver Network
1. The system shall provide a digital alarm communicator receiver (DACR) gateway with a RS 232 interface to the following digital alarm communicator receivers for wide area event reporting: Ademco 685, Silent Knight 9500 and 9800, Radionics 6600.

2. Each gateway shall support up to 10 digital alarm communicator receivers for alarm and trouble information from reporting devices.

H. Workstation Network:

1. Computers shall be networked using Ethernet supporting the use of TCP/IP protocol for local area systems.

2. The network shall be capable of supporting multiple clients (e.g., workstations, configuration applications, automated response applications) and up to ninety-nine (99) gateways.

3. A UL listed Ethernet Hub shall be provided for connection of multiple workstations, gateways, clients, and/or network printers.

4. System shall be UL listed to communicate between clients and gateways over a business computer network (shared IP).

PC Graphical Station: System Setup & Configuration:

A. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes.

B. The factory trained technician shall install initial data and artwork at each workstation including:

C. Distribution of monitoring, control and security profiles as requested by owner.

D. Area diagrams, floor plans, key maps and screen titles.

E. Auto-navigation criteria.

F. Guidance text as provided by owner.

SUBMITTALS AND DOCUMENTATION

Pre Commissioning

Prior to handover, the Contractor shall furnish with 'as fitted' drawings / wiring diagrams.

As fitted' drawings shall indicate the layout of all equipment, layout of aspirating smoke detector pipework, cable routes and cable sizes/types used. Wiring schematics, including cable termination details, shall also be provided by the Contractor.

‘As fitted’ CAD drawings shall be prepared using a software package capable of providing dwg format and two electronic copies shall be made available in that format. Also, four sets of A0 prints shall be provided to the Engineer.

Prior to handover, the Contractor shall also furnish GSI with O&M manuals. In addition to the manufacturer’s technical data sheets on all components of the system and standard operating and
maintenance instructions, the O&M manuals shall include specially written sections covering the specific operation of the system and any special maintenance requirements.

Three printed copies of the O&M manuals shall be supplied along with a copy in electronic form in a format that is computer readable, e.g. the Microsoft Office™ range of software i.e. Word™, Excel™, etc.

The following documentation shall also be provided at handover:

The site-specific software as loaded into each control panel, to be supplied in both electronic format and printed listing for secure storage on site by GSI.

Alarm audibility and/or intelligibility information. (This can be recorded on the ‘as fitted’ drawings.)

Test results for all system wiring.

Commissioning testing results/listings.

Standby battery calculations.

Contract Documentation

The Fire Alarm contractor shall provide a complete set of documents describing the system and its design concepts, installation, final testing, commissioning, and required operating and maintenance procedures.

As a minimum, the following documentation shall be provided for the system:

1. System description.

2. Checklist of equipment and components.

3. Installation instructions.

4. Equipment connection diagrams showing wiring detail of Addressable Device positions with addresses.

5. Standby battery calculations showing system power requirements and formulas used to calculate specified power.

6. Final testing instructions.

7. Commissioning instructions.

8. Certification documents.


10. System operating instructions.

11. Routine maintenance instructions and schedules.

12. Remote monitoring link description and operating instructions (if this option is being provided).

As a minimum, the following drawings shall be provided for the system:
1. System schematic diagram.
2. Cabling and wiring diagram.
3. Detailed equipment connection diagrams.
4. Building plan showing zoning and location of fire controller, detectors, call points, sounders and ancillary devices.

The Fire Alarm contractor shall provide a complete set of system operating and service manuals for the following:

1. Fire controller
2. Detectors
3. Call points
4. Sounders
5. Ancillary devices
6. Remote monitoring link (if this option is being provided).

The date for submission of all documentation shall be in accordance with the schedule provided by the Fire Alarm contractor and as agreed with the customer.

5.0 As-Built Drawings & Operating Manuals

5.1 The Contractor shall submit As-Built drawings that have been reviewed and deemed satisfactory by the Engineer. Final submission shall include four (4) sets of A1 size, one set of A3 size and two sets of electronic copy (AutoCAD files) on CD-ROM disc.

5.2 The Contractor shall submit three (3) copies of an operating manual that have been reviewed and deemed satisfactory by the Engineer

The manual should include:

General description of equipment and system.

Operating instruction for all equipment and system.

Schedule of equipment clearly stating the type, make, model, serial number, quantity, capacity, location and date of installation.

Manufacturer’s literature including catalogues, wiring diagrams, technical description, etc.

Recommended frequency and detailed task list for routine maintenance for each system and equipment

Final factory and site testing results for each equipment and each system with signatures of witnesses.

Emergency contact lists for 24-hour, 365-days including duty and backup personnel.

5.3 Closes-Out Documents
a. Submit final copies of the shop drawings outlined as above. These final submittals shall reflect all field modifications and change orders required to complete the installation. Submit the following quantities of record submittal drawings immediately following receipt of notification of substantial completion. Auto CAD drawing or VISIO files of all shop drawings on or CD ROM disks.

b. Three complete sets of documents located in a Spiral Bound notebook and organized by subject with divider tabs.

6.0 CLOSEOUT MINIMUM REQUIREMENTS

The Life Safety Contractor shall ensure the following are completed at hand-over:

a. Any snagging to be documented and agreed date determined for clearance.

b. All passwords/PIN numbers, levels and operators recorded.

c. Disk copies of all system and data files supplied.

d. Proprietary software manuals & disks.

e. Consumables, printer ribbons, printer paper at agreed levels.

f. All equipment access keys handed over.

g. Complete sets of O&M manuals left with system, any agreed amendments/additions required to be documented and a target date for completion agreed.

h. Training of engineers and operators to be checked complete or program for completion agreed.

7.0 FINAL INSPECTION:

At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

8.0 INSTRUCTION:

Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

9.0 QUALITY ASSURANCE

General

The Life Safety System shall be furnished, engineered, and installed by Trained Engineers of the Contractor.

The contractor shall have extensive knowledge in the System Network Integration or shall be a factory trained and certified Integrator.
The contractor shall employ technicians who have completed the factory authorized training. The contractor shall employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

10.0 GENERAL INSTALLATION PROCEDURES AND REQUIREMENTS.

Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All cables, junction boxes, cables supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

Typical Operational Requirement:

Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

Activate all programmed speaker circuits.

Actuate all strobe units until the panel is reset.

Light the associated indicators corresponding to active speaker circuits.

Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.

Return all elevators to the primary or alternate floor of egress.

A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.

Smoke detectors in the elevator machine room or top of hoist way shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.

Correct installation, combined with the use of high quality equipment, components and cabling, ensures that the fire detection and alarm system shall operate as designed and provide many years of trouble-free service.

The Fire Alarm contractor shall install the alarm system in accordance with the documented installation instructions.
The Fire Alarm contractor shall provide all relevant installation documentation required for each component of the system.

Installation of the system shall be in accordance with the recommendations set out in NFPA-72

The Fire Alarm contractor shall be responsible for the correct setting of all equipment and components of the system in accordance with previously agreed plans and drawings.

All cabling and wiring shall be tested before they are connected to the fire controller and its associated devices.

WARNING If the tests are carried out after the cables and wires have been connected to the controller and its devices, components within the controller and the devices will be damaged by high voltages used during testing.

Materials

All cabling and wiring to be used in the system shall be copper Armoured with conductor not less than area 1.5mm² in cross section.

Wiring used for driving devices requiring high currents (e.g. bells, etc.) shall limit the voltage drop to less than 10% of the nominal operating voltage.

Cables used for the transmission of system data and alarm signals shall be in accordance with the types recommended by the manufacturer of the fire alarm system.

The ends of all cables shall be sealed by means of proprietary seals and associated glands. No heat shall be applied to any seal or termination. Cable tails shall be insulated by means of blank PVC sleeving anchored and sealed into the seal.

Where protection of the cable glands is required or terminations are on display, the glands shall be enclosed in red coloured shrouds of the appropriate British Standard colour.

All cables to brick/concrete shall be securely fixed by means of copper saddles sheathed with red PVC. These saddles shall be provided near bends and on straight runs at intervals no greater than recommended in the British Standards or by the manufacturer.

Where multiple cables are to be attached to a wall or soffit, copper saddles shall enclose all cables and shall be secured by means of suitable masonry plugs and two round head plated woodscrews.

Where multiple cables are to be attached to the top of horizontal trays they shall be neatly run and securely fixed at suitable intervals. Copper or plastic cable fixings shall be used.

At detector and sounder locations, cables shall be terminated in approved galvanized junction boxes. All other devices forming part of the system shall utilize dedicated /custom back boxes.

Installation of Detectors

All detectors (and bases) shall be installed in accordance with guidelines set out in NFPA -72 and the installation instructions provided by the manufacturer.
All detectors shall be installed in the exact locations specified in the design drawings; thus providing the best possible protection.

The type of detector installed in each particular location shall be the type specified in the design drawings.

All detector bases shall be securely fixed to approved boxes and allow for easy fitting and removal of detectors.

Cable and wire entries to detector bases shall be fitted with grommets to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at all entries to detector bases.

Cable entries of detector bases used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

Installation of Control Devices

All control devices (e.g. call points, sounders, interface modules, etc.) shall be installed in accordance with the guidelines set out in NFPA-72 and the installation instructions provided by the manufacturer.

All control devices and associated modules shall be installed in the exact locations specified in the design drawings.

The type of control device installed in each particular location shall be the type specified in the design drawings.

All control devices and associated modules shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

Cable and wire entries to all control devices and associated modules shall be fitted with grommets or glands so as to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at entries to control devices and associated modules as required.

Cable entries of control devices and associated modules used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

Installation of Fire Controller Equipment

The fire controller equipment shall be installed in accordance with the guidelines set out in NFPA-72 and the installation instructions provided by the manufacturer.

The fire controller and its associated component parts shall be installed in the location specified in the design drawings.

The type of fire controller and its associated component parts installed shall be the type specified in the design drawings.
The fire controller equipment shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

Cable and wire entries to the fire controller and associated devices shall be fitted with grommets or glands to prevent possible damage to the insulation.

Cable and wire strain relief clamps shall be provided at entries to fire controller and associated devices as required.

The fire alarm system mains power connections to the fire controller equipment shall be accordance with the guidelines set out in the relevant British Standards and the installation instructions provided by the manufacturer.

The fire alarm system mains power isolating switch shall be coloured red and clearly labeled ‘FIRE ALARM: DO NOT SWITCH OFF’.

Each circuit of the system shall be connected to the fire controller via associated fuse or circuit breaker devices located within the fire controller unit.

All cables from the fire controller equipment to the detection and alarm devices shall be clearly labeled as part of the fire detection and alarm system.

11.0 TESTING AND COMMISSIONING, TRAINING

Initial testing can be carried out as per following but not limiting to:-

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Visual</th>
<th>Test Readings</th>
<th>Documentation</th>
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<tbody>
<tr>
<td>1</td>
<td>All cables are tested for continuity, insulation, resistance etc.</td>
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<td>2</td>
<td>Carry out visual checks on all panels, cables, interphase modules etc. to ensure they are clean and free from any mechanical damage</td>
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<td>3</td>
<td>Check for proper termination &amp; feruling</td>
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<td></td>
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<td>4</td>
<td>Check input A/C supply voltage</td>
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<tr>
<td>5</td>
<td>Check location/spacing of Detectors as per standards</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>6</td>
<td>All device are addressed as per drawing</td>
<td></td>
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<td>√</td>
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<tr>
<td>7</td>
<td>Check Distribution of Detector / Loops / Zones as per Drawing.</td>
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<td>√</td>
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<tr>
<td>8</td>
<td>Check all Modules / Detectors, for healthy blinking status.</td>
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<td>√</td>
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<tr>
<td>9</td>
<td>Apply Smoke / Aerosol to random detectors &amp; check output</td>
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<td>of the same in panel, shall display proper</td>
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Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

Verify activation of all flow switches.

Open initiating device circuits and verify that the trouble signal actuates.

Open signaling line circuits and verify that the trouble signal actuates.

Open and short notification appliance circuits and verify that trouble signal actuates.

Ground initiating device circuits and verify response of trouble signals.

Ground signaling line circuits and verify response of trouble signals.

Ground notification appliance circuits and verify response of trouble signals.

Check presence and audibility of tone at all alarm notification devices.

Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.

Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

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When the system is equipped with optional features, the manufacturer’s manual should be consulted to
determine the proper testing procedures. This is intended to address such items as verifying controls
performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality
and similar.

12.0 COMMISSIONING (Pre Commissioning)

At final commissioning of each system, the Contractor shall confirm that:

All detection devices, including point detectors, beam smoke detectors, flame detectors, and
aspirating smoke detectors and inputs are tested and operate correctly.

All manual controls, whether manual call points or centrally located controls, operate correctly.

The correct indications are given at the control and indicating equipment, including the repeater panels,
mimic panels and graphics PC central control and display terminal.

All outputs operate, in the required manner, including alarm sounders or voice alarm system
loudspeakers, visual indicators and connections to ancillary services and other systems. In particular,
the Contractor shall check that audibility levels of sounders and/or audibility and intelligibility of voice
alarm broadcasts are correct.

The fire detection and fire alarm system complies with the operational sequence detailed in Section 5 of
this Specification.

The standby batteries are adequately sized. (Measurements of the quiescent and alarm loads shall be
taken and compared to calculated values used at the design stage.) Calculations and measurements
shall be submitted to the Engineer.

Commissioning shall be fully documented and the documentation submitted to the Engineer.

The Contractor shall demonstrate each fire detection and fire alarm system to the satisfaction of the
Engineer by conducting a series of witnessed acceptance tests as directed by the Engineer. This shall
take place after the above final commissioning and following receipt of the commissioning
documentation by the Engineer. Acceptance testing shall include the actuation of all devices in the
system, simulation of various faults and operation of all manual controls.

Following commissioning, a system soak period of not less than one week shall follow, unless the system
incorporates fewer than 50 automatic fire detectors, in which case no soak test is necessary.

Both the installation and the commissioning activities shall be undertaken as a single continuous
operation.

Upon completion of the installation activity, the Fire Alarm contractor shall Test, Start-up, Commission
and Handover the system to the customer.

The Fire Alarm contractor shall make use of the following documents to record test results and details of
commissioning tests:

Cable Test Sheets

Installation Check Report
The Fire Alarm contractor shall be responsible for inspecting and testing the complete system, including:

1. Detectors
2. Call Points
3. Sounders
4. Ancillary Devices
5. Fire Controller Equipment and Associated Devices
6. Auxiliary Equipment (e.g. Plant Interface Module, etc.)
7. Operating and Control Software.

The fire controller and associated devices and modules shall be tested in accordance with the guidelines set out in NFPA-72 and the testing instructions provider by the manufacturer.

The Fire Alarm contractor shall start up and operate the system for a trial period to ensure that it operates correctly.

The Fire Alarm contractor shall test all functions of the system, including the software, to ensure that it operates in accordance with the requirements of the design specification and relevant standards.

The Fire Alarm contractor shall undertake audibility tests during which the sounders may be operated continuously over a period of two hours. (Should the customer require these tests to be carried out at a separate visit, or out of normal working hours, this can be arranged at additional cost.)

Commissioning of the system shall constitute practical completion

Following the satisfactory completion of installation, testing and start up, the Fire Alarm contractor shall demonstrate to the customer that the system successfully performs all of the functions set out in the design specification.

The Fire Alarm contractor shall provide the customer with an agreed quantity of spare parts testing equipment and consumables which are to be used during routine maintenance and testing of the system.

The Fire Alarm contractor shall provide a customer appointed fire system supervisor with on-site training in the use, operation and maintenance of the system and explain the procedures to be followed in the event of fire and false alarms. The system supervisor shall also be shown how to carry out routine maintenance and testing procedures, and how to keep the Log Book.

The Fire Alarm contractor shall prepare a report detailing all tests performed during installation and commissioning of the system. The report shall include the results of the tests and details of any specific settings or adjustments made. Any outstanding tasks or activities which are to be completed at another time shall also be included in the report.
The Fire Alarm contractor shall present an Acceptance Certificate for signature by the customer.

13.0 TRAINING OF OPERATING PERSONNEL:

All training shall be by the Building Controls Contractor and shall utilize specified manuals, as-built documentation, and the on-line help utility.

Operator training shall include four initial eight-hour sessions.

The initial operator training program shall be to establish a basic understanding of Windows based software, functions, commands ETC.

Special Emphasis shall be laid by the Trainer on imparting knowledge to the participants on extracting the maximum mileage out of the Head-end application to achieve energy monitoring and efficiency.

Participants should be trained in the concept of maximum demand load management and the process logic applied by the IBMS system to achieve the same.

The training shall encompass as a minimum:

Troubleshooting of input devices, i.e., bad sensors.

Sequence of operation review.

Sign on - sign off.

Selection of all displays and reports.

Use of all dialogue boxes and menus.

System initialization.

GUI Software.

Network Management Software.

14. INTERFACING WITH OTHER SERVICES.

Interfacing with Third Party Service providers and Equipment Providers is a integral and most important part of the scope of works of the IBMS vendor.

It shall be the Contractor’s responsibility to study and inclulate the Design Logics of various Utilities being provided by third parties.

It is expected and assumed for granted that the Contractor shall study of third party drawings to locate equipment / locate Marshalling boxes to pick up signals relevant to Control and Monitoring of Life Safety

The Contractor shall also prepare and share data related to software level integrations to the IBMS contractor on .net / xml / or conventional integration on MODBUS / LONWORKS / BACNET over IP Platforms, made availabe either on Serial interface or on a IP Platform.

The Contractor shall be responsible to ensure that all information relevant to Interfacing with Other Services and Other Systems is collated an put to use to ensure a fully operational Life Safety System as
per technical requirements put forth in the Tender, and to the description of the Architect / Client / Consultant as Directed from Time to Time.

During Execution, it shall be Contractor’s responsibility to follow Co-ordinated drawings and interface with other Services and contractors for proper laying and installation of equipment such that there is no fouling of services in any manner.

C. CCTV (IP VIDEO SURVEILLANCE) SYSTEM

SCOPE:

The specification of Video Surveillance System covers technical specification and requirement of IP Video Surveillance Systems consisting of Indoor IP dome cameras, Indoor IP PTZ cameras, outdoor IP P/T/Z dome cameras, Video Management Software, Recording servers, switches, colour monitor etc. for surveillance of the facility from a centralized location.

Video Surveillance System shall be an IP enabled system. The recording of the video shall be on an open architecture, non-embedded based recorder server from reputed manufacturers like IBM/HP/Dell. The system shall be able to work on a fibre optic backbone network. The entire system shall be based on nonproprietary open architecture where the Video Management software can work and integrate with any make of standard cameras and encoders, and IT hardware.

SYSTEM DESCRIPTION

The Video Management Software should be a fully digital IP-based video surveillance system.

The VMS should work with the latest compression technologies viz MPEG-4 and H.264 and should be capable to interface with IP cameras streaming both compressions.

It should be a fully scalable enterprise-class media management system. This advanced network-based system architecture should enable simultaneous live monitoring from multiple stations and be easily configurable for storage both on and off site. The software should be configured to store and to view images captured by one camera or thousands of cameras and monitor connections across an unlimited number of servers.

Video Surveillance System shall consist of outdoor IP PTZ Dome cameras, recording Servers and PC’s and associated Ethernet cable, fiber cable, video cable, power cable, twisted pair cable etc. Bidder should consider all necessary network equipment and accessories to provide a LAN / WAN infrastructure dedicated for video surveillance on a fibre optic backbone network which should be not less than 1 Gbps speed.

The software should provide a single GUI that monitors, records, and offers analysis functionality to deliver the timely, accurate information required for effectively responding to any challenge.

The VMS shall have client station software. The client should offer multi-monitor options, and have drag and drop options and the ability to switch any particular camera onto any monitor through drag operation.

It should be possible to set up a video wall from the software.
The VMS should have the future capability to integrate video analytics for all the cameras. It should presently support motion detection feature and detect on the basis of size of object and direction of movement etc. and generate various types of alarms.

Each camera shall have a video at 4CIF and 25 frames for viewing the videos during live as well as for recording purpose. The storage shall be on a recording server which will be a standard IBM/HP/Dell/make PC server. The recording shall be stored for at least 30 days at 4CIF and 25 frames per second.

SYSTEM ARCHITECTURE

The following diagram explains the relationship of various system and integration components:
4. GENERAL REQUIREMENTS:
   
i. Manufactured products shall have quality system compliance and shall be either UL, CE or FCC Certifies.
   
   ii. The Video Management software and the Cameras should be ONVIF compliant to integrate with third party system.
   
   iii. All software and firmware upgrades shall be free of cost. All the IP cameras shall be freely accessible and programmable from the control room.
   
   iv. Every control room of surveillance system shall be capable of getting connected to the optical or other communication backbone.
   
   v. The power supply available shall be 220 V / 50 Hz AC +/- 10%. All modules of the surveillance system should work using this power supply only with requisite converters, if required.
   
   vi. All the cameras and other modules of Video Surveillance System shall be modular in construction. In case of upgradation of such modules in future, it shall be possible to upgrade them without replacing the entire modules.

TECHNICAL REQUIREMENTS:

The Video Surveillance System shall consist of:

5.1 Indoor Fixed IP Dome with Color (Day/ Night) Camera

The following cameras will be provided with Appropriate Lens, housing and support to work indoor in industrial environment. The camera should meet the following minimum requirement.

- **Image sensor**: The camera shall use a 1/2.8” Progressive Scan RGB CMOS
- **Lens**: Varifocal 2.8 - 10 mm, F1.7, fixed iris
- **Angle of view, horizontal**: 22° - 80°
- **Minimum illumination**: color 0.05 Lux, 0 Lux with IR, IR distance upto 30 mtr
- **Camera angle adjustment**: Pan 360°, tilt 170°, rotation 340°
- **Video compression**: H.264, H.265
- **Resolutions**: 640 X 480 to 2048 X 1536 (3MP)
- **Frame rate**: 30fps in all resolutions (H.264 & H.265)
- **Video Streaming**: Multiple, individually configurable streams in H.264
- **Intelligent video**: Video motion detection, active tampering alarm
- **Security**: Password protection, IP address filtering, HTTPS encryption, digest authentication, user access log
Supported protocols: IPv4/v6, HTTP, HTTPS, FTP, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3(MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, ICMP, DHCP, ARP.

Approvals: UL, CE/FCC

Network: IPv4/v6, QoS

Power over Ethernet

(IEEE 802.3af /): Class 2 (max. 7W)

Serial Connectors: RS-45 10BASE-T/100BASE-TX PoE

5.2 Fixed Color (day/night) Camera with IP 66 Housing

The following cameras will be provided with appropriate lens, housing and support to work in industrial environment. Housing will be provided in all the cameras with IP66 rating with heater and blower. The camera should meet the following minimum requirement.

Image sensor: The camera shall use a “½.8” Progressive scan CMOS

Lens: Camera should support both CS-mount & DC-iris lenses; Varifocal 4-10 and 5-50 mm: F1.8, P-Iris; horizontal: 29° - 61°

Angle of view, horizontal: Horizontal: 29° - 61

Minimum illumination: Color: 0.6 lux, B/W: 0.08 lux, F1.8

Shutter time: 1/10000 s to 1/1 s

Video compression: H.264, Motion JPEG

Resolutions: 640 X 480 to 2048 X 1536 (3 MP)

Frame rate: 3MP MP2048 X 1536 @ 30 FPS, 1080 (1920 x 1080) @60 fps

Video streaming: Multiple, individually configurable stream in H.264 and Motion JPEG. Controllable frame rate and bandwidth VBR/CBR H.264. Up to 8 individually cropped out view areas. When streaming 5 view areas in VGA resolution, the rate is 20 fps per stream in H.264/Motion JPEG (3 MP capture mode)

Image setting: Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, wide dynamic range, dynamic contrast, fine tuning of behavior at low light

Security: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log

Supported protocols: IPv4/v6, HTTP, HTTPS, FTP, SMTP, UPnP, SNMPv1/v2c/v3(MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, ICMP, DHCP, ARP.
Approvals: UL, CE/FCC

Power: 9.6W PoE Class 3, IEEE 802.3af Power over Ethernet

FIXED COLOR (Day/ Night) CAMERA WITH IP-66 HOUSING

The following cameras will be provided with Appropriate Lens, housing and support to work in industrial environment. Housing will be provided in all the cameras with IP66 rating with heater and blower. The camera should meet the following minimum requirement.

Image sensor: The camera shall use a “½.8 Progressive scan CMOS 2 Megapixel

Lens: f 5 – 50mm, F1.8 - 2.1, Auto day/night IR filter, autofocus Near focus limit 10mm (wide) or 800mm (tele)

Angle of view, horizontal: horizontal: 5.4° - 50°, M37x0.75 mounting thread for optional lens adaptor

Minimum illumination: Color: 2 lux at 30IRE, F1.8, B/W: 0.2 lux at 30IRE, F1.8

Zoom: 10x optical and 12x digital, total 120 xs

Video compression: H.264, Motion JPEG

Resolutions: 640 X 480 to 2048 X 1536 (3 MP)

Frame rate: 3MP MP2048 X 1536 @ 30 FPS, 1080 (1920 x 1080) @60 fps

Intelligent video: Video motion detection, active tampering alarm

Security: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log

Supported protocols: IPv4/v6, HTTP, HTTPS, FTP, SMTP, UPnP, SNMPv1/v2c/v3(MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, ICMP, DHCP, ARP.

Approvals: UL, CE/Network: IPv4/v6, QoS

Power: 8 – 20 VDC max 11,2 W, 20 - 24 V AC max 17,4 VA, Power over Ethernet IEEE 802.3af Class 3

Serial Connectors: RS-45 10BASE-T/100BASE-TX PoE

5.4 PTZ Network Camera (day and night) with Housing

It shall be for indoor or outdoor purpose type with minimum of following details to work properly in industrial and hilly environment. Housing will be provided in all the cameras with IP66 rating with heater and blower. The camera should meet the following minimum requirement.

Image Sensor: The camera shall use a” ½.8” interlaced CCD

Day night: Autofocus
5.5 PTZ Network Camera (day and night) with Housing

It shall be for indoor or outdoor purpose type with minimum of following details to work properly in industrial and hilly environment. Housing will be provided in all the cameras with IP66 rating with heater and blower. The camera should meet the following minimum requirement.

Image Sensor: The camera shall use a ½.8 ExView HAD Progressive Scan CCD

Day night: Autofocus, automatic day/night

Lens: 4.3 to 129 , F1.6 horizontal angle of view: 2.4 deg to 64 deg

Minimum illumination/

Light Sensitivity (LUX): Color 0.5 lux , B/W 0 lux with IR

Shutter time: 1/10000 s to 1/1s
PAN/Tilt/Zoom: E-flip; 100 preset positions; Pan: 360° endless 0.1 to 300 deg/s; Tilt: 180°, 0.1 to 200 deg/s°/; 30 Xoptical zoom and 12x digital zoom, total 320 Xzoom; Guard
Tour; Control queue

Video compression: H.264 (MPEG-4 Part 10/AVC); Motion JPEG, H.265

Resolutions: 640 X 480 to 2048 X 1536 (3MP)

Frame per second

(NTSC/PAL): Up to 30/25fps in all resolutions, 50/60 FPS in 2MP

Security: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log

Supported protocols: IPv4/v6, HTTP, HTTPS, FTP, SMTP, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, ICMP, DHCP, ARP.

Casing: IP66-rated, metal casing (aluminum sunshield (polycarbonate)

Power: 24V AC

Operating condition: -40 - 50 °C (-40 - 122 °F) Arctic Temperature Control enables camera start-up at temperatures as low as -40C; Humidity 20 – 80% RH (non-condensing)

Approvals: EN 55022 Class B, EN 55024, EN 61000-3-2, EN 61000-3-3, EN 61000-6-1, EN 61000-6-2, FCC Part 15 Subpart B Class B, VCCI Class B, C-tick AS/NZS CISPR22, ICES-003 Class B, EN 60950-1; Midspan: EN 60950-1, GS, UL, cUL, CE,

DIGITAL KEYBOARD

Professional joystick for accurate control over network of PTZ (pan/tilt/zoom) and dome network cameras. Connects to PC workstation over USB.

7. TECHNICAL SPECIFICATION FOR 24 PORT POE 10/100/1000 MBPS LAYER 3 SWITCH

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Desired Specification/Qualitative Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Core / Distribution Switches (Layer 3)</td>
</tr>
<tr>
<td>1.1</td>
<td>Architecture</td>
</tr>
<tr>
<td>(a)</td>
<td>Modular switch with 24 Manageable Gigabit Ethernet ports, 4 RJ 45 ports with option of fibre port of Min 1000 mbps &amp; 03 No’s of 10 Gigabit Slots for uplink to Switch or Servers for Stacking.</td>
</tr>
<tr>
<td>(b)</td>
<td>Switch should provide option of Redundant power supply</td>
</tr>
<tr>
<td>Sr No</td>
<td>Desired Specification/Qualitative Requirement</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>1.2</td>
<td>Network Media</td>
</tr>
<tr>
<td>(a)</td>
<td>SFP’s 1000BaseSX,1000BaseLX,1000BaseTX,1000Base Lx WDM</td>
</tr>
<tr>
<td>1.3</td>
<td>Performance</td>
</tr>
<tr>
<td>(a)</td>
<td>The Switch shall have Non-blocking wire speed switch fabric</td>
</tr>
<tr>
<td>(b)</td>
<td>The Switch shall have Min. 100 Gbps Back plane</td>
</tr>
<tr>
<td>(c)</td>
<td>The Switch shall have Min.80 million pps</td>
</tr>
<tr>
<td>(d)</td>
<td>The Switch shall support Min. 16K Mac address</td>
</tr>
<tr>
<td>(e)</td>
<td>The Switch shall support Min. 3000 VLANs</td>
</tr>
<tr>
<td>(f)</td>
<td>The Switch shall support IPv4/IPv6 Routing</td>
</tr>
<tr>
<td>(g)</td>
<td>The Switch shall have 40 Gigabit Stacking Backplane</td>
</tr>
<tr>
<td>(h)</td>
<td>The Switch shall be able to do Physical Stack up to 10 units per stack or more</td>
</tr>
<tr>
<td>(i)</td>
<td>The Switch shall be able to do IP Stacking up to 30 units per IP</td>
</tr>
<tr>
<td>(j)</td>
<td>The Switch Should support Jumbo Frame (up to 9216 Bytes)</td>
</tr>
<tr>
<td>1.4</td>
<td>Layer 3 Features</td>
</tr>
<tr>
<td>(a)</td>
<td>The Switch should have RIPv1(RFC1058)/RIPv2(RFC2453),RIPng,OSPFv2</td>
</tr>
<tr>
<td>(b)</td>
<td>The Switch should have Policy Based Routing ,BGP 4 &amp; VRRP</td>
</tr>
<tr>
<td>(c)</td>
<td>The Switch should have DVMRP v3, PIM-DM/SM/SDM for IPv4</td>
</tr>
<tr>
<td>(d)</td>
<td>The Switch should have IPv6 Tunneling</td>
</tr>
<tr>
<td>(e)</td>
<td>The Switch should have Up to 56 IP Interfaces &amp; 10K route entries</td>
</tr>
<tr>
<td>(f)</td>
<td>The Switch should have Multi Path Routing support for Equal cost &amp; Weighted Cost</td>
</tr>
<tr>
<td>(g)</td>
<td>The Switch should have Per port Limit IP Multicast Address Range for Control Packet</td>
</tr>
<tr>
<td>1.5</td>
<td>Layer 2 Features</td>
</tr>
<tr>
<td>(a)</td>
<td>The Switch should have IGMP Snooping v1,v2,v3 &amp; MLD Snooping</td>
</tr>
<tr>
<td>(b)</td>
<td>The Switch should have Spanning tree 802.1d,802.1w,802.1s</td>
</tr>
<tr>
<td>(c)</td>
<td>The Switch should have 802.3ad Link Aggregation Up to 30 groups per device</td>
</tr>
<tr>
<td>Sr No</td>
<td>Desired Specification/Qualitative Requirement</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>(d)</td>
<td>The Switch should have Port Mirroring One to one/Many to One &amp; RSPAN</td>
</tr>
<tr>
<td>(e)</td>
<td>The Switch shall have the intelligence to detect the loop occurring from the unmanaged network segment</td>
</tr>
<tr>
<td>(f)</td>
<td>The Switch shall have the capability to build the trunk across stack</td>
</tr>
<tr>
<td>(g)</td>
<td>The Switch shall have ITU-T G.8032</td>
</tr>
<tr>
<td>(h)</td>
<td>It shall support LLDP and LLDP-MED including client location information. It shall exchange link and device information in multi vendor networks</td>
</tr>
<tr>
<td>1.6</td>
<td>VLAN</td>
</tr>
<tr>
<td>(a)</td>
<td>The LAN switch shall have IEEE 802.1Q VLAN encapsulation. Up to 255 VLANs per switch and up to 4000 VLAN IDs.</td>
</tr>
<tr>
<td>(b)</td>
<td>It shall have Automatic Negotiation of Trunking Protocol, to help minimize the configuration &amp; errors.</td>
</tr>
<tr>
<td>(c)</td>
<td>It shall have centralized VLAN Management. VLANs created on the Core Switches shall be propagated to all the others switches automatically, thus reducing the overhead of creating/modifying/deleting VLANs in all the switches in turn eliminating the configuration errors &amp; troubleshooting.</td>
</tr>
<tr>
<td>(d)</td>
<td>It shall have support for Detection of Unidirectional links and to disable them to avoid problems such as spanning tree loops</td>
</tr>
<tr>
<td>(e)</td>
<td>It shall support 802.1v &amp;Q-in-Q Vlan</td>
</tr>
<tr>
<td>1.7</td>
<td>Quality of Service</td>
</tr>
<tr>
<td>(a)</td>
<td>It shall support 802.1p Priority Queues (8 Queues)</td>
</tr>
<tr>
<td>(b)</td>
<td>Queue Handling mode: WRR &amp; Strict Mode</td>
</tr>
<tr>
<td>(c)</td>
<td>Granular Rate Limiting functions on per port &amp; flow based to guarantee bandwidth in increments shall be as low as 64 Kilobits per Second.</td>
</tr>
<tr>
<td>(d)</td>
<td>Class of shall be based on Switch port, DSCP, Vlan ID,TCP/UDP port, Protocol type,802.1p queues, IPv4/v6 address, IPv6 flow label &amp; User defined packet content</td>
</tr>
<tr>
<td>(e)</td>
<td>The Switch shall be MEF 9 &amp; 14 Certified to ensure the Service Level Agreements for Voice, video &amp; Data converged applications</td>
</tr>
<tr>
<td>1.8</td>
<td>Access Control List</td>
</tr>
<tr>
<td>(a)</td>
<td>The Lan Switch shall have the capability to apply access list control based on</td>
</tr>
<tr>
<td>Sr No</td>
<td>Desired Specification/Qualitative Requirement</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>IPv4/v6 address, Protocol type, IPv6 flow label, Time based ACL, Vlan-ID, MAC-ID, DSCP, IPv6 traffic class, TCP/UDP Port, Switch port &amp; user defined packet content</td>
</tr>
<tr>
<td>(b)</td>
<td>The Switch shall support up to 1600 Access Control Entries minimum</td>
</tr>
</tbody>
</table>

### 1.9 Network Security

(a) The LAN switch shall support IEEE 802.1x to allow dynamic, port-based security, providing user authentication.

(b) The LAN switch shall support for Admission Control features to improve the network’s ability to automatically identify, prevent and respond to security threats and also to enable the switches to collaborate with third-party such as Microsoft for security-policy compliance and enforcement before a host is permitted to access the network.

(c) It shall support for SSHv2, SNMPv3 to provide network security by encrypting administrator traffic during Telnet and SNMP sessions.

(d) It shall support RADIUS authentication to enable centralized control of the switch and restrict unauthorized users from altering the configuration.

(e) It shall support DHCP snooping to allow administrators to ensure consistent mapping of IP to MAC addresses. This can be used to prevent attacks that attempt to poison the DHCP binding database, and to rate limit the amount of DHCP traffic that enters a switch port.

(f) It shall support DHCP Interface Tracker (Option 82) to augment a host IP address request with the switch port ID.

(g) It shall support that each end node can be isolated from each other and they should be able to connect to shared ports such as Internet and servers

(h) It shall support port security to secure the access to an access or trunk port based on MAC address. After a specific timeframe, the aging feature should remove the MAC address from the switch to allow another device to connect to the same port. (up to 14 MAC-ID per port)

(i) It shall have IP-MAC-Port binding up to 475 Entries per device

(j) It shall have Web & MAC Based Access Control

### 1.10 Management

(a) The LAN switch shall have CLI support to provide a common user interface and command set with all routers and switches of the same vendor.
<table>
<thead>
<tr>
<th>Sr No</th>
<th>Desired Specification/Qualitative Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>It shall have Remote Monitoring (RMON) software agent to support four RMON groups (history, statistics, alarms and events) for enhanced traffic management, monitoring and analysis.</td>
</tr>
<tr>
<td>(c)</td>
<td>It shall support Trivial File Transfer Protocol (TFTP) to reduce the cost of administering software upgrades by downloading from a centralized location.</td>
</tr>
<tr>
<td>(d)</td>
<td>It shall support Network Timing Protocol (NTP/SNTP) to provide an accurate and consistent timestamp to all intranet switches.</td>
</tr>
<tr>
<td>(e)</td>
<td>It shall support SNMPv1, SNMPv2c, and SNMPv3 and Telnet interface to deliver comprehensive in-band management, and a CLI-based management console to provide detailed out-of-band management.</td>
</tr>
<tr>
<td>(f)</td>
<td>It shall provide management functions for network segments (access links and individual circuits), monitors individual links.</td>
</tr>
<tr>
<td>(g)</td>
<td>It shall have traffic monitoring for all network ports effective at gigabit speed or higher, shall not impact the network performance while providing the real time &amp; historical data of all devices from Layer 2 to Layer 7.</td>
</tr>
<tr>
<td>(h)</td>
<td>It shall support configuration rollback to replace current configuration with any saved configuration file.</td>
</tr>
</tbody>
</table>

**TECHNICAL SPECIFICATION FOR 24 POE PORT 10/100/1000 MBPS LAYER 2 SWITCH**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Desired Specification/Qualitative Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Edge Switch (Layer 2)</td>
</tr>
<tr>
<td>1.1</td>
<td>Architecture</td>
</tr>
<tr>
<td>(a)</td>
<td>Modular switch with 24 POE Manageable Gigabit Ethernet ports, 2 ports with option of fibreport of Min 1000 mbps.</td>
</tr>
<tr>
<td>(b)</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Network Media</td>
</tr>
<tr>
<td>(a)</td>
<td>SFP’s 1000BaseSX, 1000BaseLX, 1000BaseTX</td>
</tr>
<tr>
<td>1.3</td>
<td>Performance</td>
</tr>
<tr>
<td>(a)</td>
<td>The Switch shall have Non-blocking wire speed switch fabric</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Sr No</th>
<th>Desired Specification/Qualitative Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>The Switch shall have Min. 48 Gbps Back plane or higher</td>
</tr>
<tr>
<td>(c)</td>
<td>The Switch shall have Min. 35 million pps or higher</td>
</tr>
<tr>
<td>(d)</td>
<td>The Switch shall support Min. 8K Mac address</td>
</tr>
<tr>
<td>(e)</td>
<td>The Switch shall support Min. 256 VLANs</td>
</tr>
<tr>
<td>(f)</td>
<td>The L2 Switch should have MTBF for 173,467 hours.</td>
</tr>
<tr>
<td>(g)</td>
<td>The Switch Should support Jumbo Frame (up to 9216 Bytes)</td>
</tr>
</tbody>
</table>

1.4 Layer 2 Features

| (a)   | The Switch should have IGMP Snooping v1, v2 |
| (b)   | The Switch should have Spanning tree 802.1d |
| (c)   | The Switch should have 802.3ad Link Aggregation Up to 6 groups per device |
| (d)   | The Switch should have Port Mirroring One to one/Many to One |
| (e)   | The L2 Switch shall have power saving feature which can automatically powers down ports that have no link or link partner. |
| (f)   | The L2 Switch shall have power budget upto 370 W or better |

1.5 VLAN

| (a)   | The LAN switch shall have IEEE 802.1Q VLAN encapsulation. Up to 255 VLANs per switch. |
| (b)   | It shall have Management Vlan |
| (c)   | It shall have Asymmetric Vlan |

1.6 Quality of Service

| (a)   | It shall support 802.1p Priority Queues (4 Queues) |
| (b)   | Queue Handling mode: WRR & Strict Mode |
| (c)   | Class of service shall be based on DSCP, 802.1p queues |

1.7 Network Security

| (a)   | The LAN switch shall support IEEE 802.1x to allow dynamic, port-based security, providing user authentication. |
| (b)   | It shall support RADIUS authentication to enable centralized control of the switch and |
restrict unauthorized users from altering the configuration.

(c) It shall have built in mechanism to protect the switch against traffic flooding caused by virus attack

1.8 Management

(a) It shall support Firmware upgrade through Web Management or through software must come along with Switch to reduce the cost of administering software upgrades by downloading from a centralized location.

(b) It shall support Network Timing Protocol (NTP/SNTP) to provide an accurate and consistent timestamp to all intranet switches.

(c) It shall support SNMPv1 to deliver comprehensive in-band management

(d) It shall support configuration rollback to replace current configuration with any saved configuration file.

11. CABLING SYSTEM AND COMPONENT SPECIFICATIONS

11.1 UTP Cabling System

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details</th>
<th>Specification</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Unshielded twisted pair cabling system, TIA / EIA 568-B.1 or B.2-1 addendum Category 6 Cabling system</td>
<td>Yes / No</td>
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</tr>
<tr>
<td>2</td>
<td>Networks Supported</td>
<td>10 / 100/1000 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>3</td>
<td>TIA / EIA 568-B.1 or B.2.1</td>
<td>ETL Verified / UL Listed</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>4</td>
<td>Warranty</td>
<td>25 year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the</td>
<td>Yes / No</td>
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<tr>
<td>S.No.</td>
<td>Details</td>
<td>Specification</td>
<td>Compliance</td>
<td>Deviation</td>
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<tr>
<td>1</td>
<td>Type</td>
<td>Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2-1</td>
<td>Yes / No</td>
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<td>2</td>
<td>Conductors</td>
<td>23 AWG solid bare copper</td>
<td>Yes / No</td>
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<tr>
<td>3</td>
<td>Insulation</td>
<td>Polyethylene</td>
<td>Yes / No</td>
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<tr>
<td>4</td>
<td>Jacket</td>
<td>Flame Retardant PVC</td>
<td>Yes / No</td>
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<tr>
<td></td>
<td>Pair Separator</td>
<td>Cross-member (+) fluted Spline.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Approvals</td>
<td>(a) UL Listed / UL Verified</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(b) ETL verified to TIA / EIA Cat 6</td>
<td>Yes / No</td>
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<tr>
<td>6</td>
<td>Operating temperature</td>
<td>-20 Deg. C to +60 Deg. C</td>
<td>Yes / No</td>
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<td></td>
<td>Storage Temperature</td>
<td>-20 Deg. C to +80 Deg. C</td>
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<td>No.</td>
<td>Specification</td>
<td>Value</td>
<td>Yes / No</td>
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<tr>
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<td>---------------------------------------</td>
<td>--------------------------------------------</td>
<td>----------</td>
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<td>7</td>
<td>Frequency tested up to</td>
<td>Minimum 600 MHz</td>
<td>Yes / No</td>
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<td>8</td>
<td>Packing</td>
<td>Box of 305 meters</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>9</td>
<td>Cable Outer Diameter</td>
<td>.23 inches</td>
<td>Yes / No</td>
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<td>10</td>
<td>Delay Skew</td>
<td>45ns MAX.</td>
<td>Yes / No</td>
<td></td>
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<td>11</td>
<td>Bend Radius</td>
<td>4 * Cable Diameter</td>
<td>Yes / No</td>
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<tr>
<td>12</td>
<td>Impedance</td>
<td>100 Ohms + / - 15 ohms, 1 to 600 MHz.</td>
<td>Yes / No</td>
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<td>13</td>
<td>UL/NEC Ratings</td>
<td>CMR Rated</td>
<td>Yes / No</td>
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<td>14</td>
<td>Mutual Capacitance</td>
<td>5.6 NF MAX /100 Mtr.</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>15</td>
<td>Conductor Resistance</td>
<td>66.58 Ohms Max / KM</td>
<td>Yes / No</td>
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<tr>
<td>16</td>
<td>Propagation Delay</td>
<td>536 ns/100 Mtrs. MAX @ 250 Mhz</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>17</td>
<td>Performance characteristics to be provided along with bid</td>
<td>Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>18</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
<td>Yes / No</td>
<td></td>
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</tbody>
</table>
### UTP Jacks

<table>
<thead>
<tr>
<th>S No.</th>
<th>Details</th>
<th>Specification</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>PCB based, Unshielded Twisted Pair, Category 6, TIA /EIA 568-B.2-1 and IEC 60603-7-4</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Modular Jack</td>
<td>750 mating cycles</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Wire terminal</td>
<td>200 termination cycles</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Accessories</td>
<td>Integrated bend-limiting strain-relief unit for cable entry</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated hinged dust cover</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support cable pair termination process on the jacks at 90 degree angle.</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bidder should have a mechanism to maintain the quality of the termination ir-respective of the skill level of the termination staff.</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Housing</td>
<td>Polyphenylene oxide, 94V-0 rated.</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>110 Blocks</td>
<td>Polycarbonate, 94V-0 rated</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Jack contacts</td>
<td>Beryllium copper, plated with 1.27 mm [.000050] thick gold in localized area and 3.81 mm [.000150] minimum thick tin-lead in solder area over 1.27 mm [.000050] minimum thick nickel under plate</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Wiring blocks</td>
<td>Polycarbonate, 94V-0 rated</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Approvals</td>
<td>(a) UL Listed / CSA Approved</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) ETL verified to TIA / EIA Cat 6</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Performance Characteristics to be provided with bid</td>
<td>Attenuation, NEXT, PS NEXT, FEXT and Return Loss</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>11</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
<td>Yes / No</td>
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</table>
### 11.4 Patch Cords

<table>
<thead>
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<th>S.No.</th>
<th>Details</th>
<th>Specification</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2-1</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>2</td>
<td>Conductor</td>
<td>24 AWG 7 / 32, stranded copper conductors 100 Ohm</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Length</td>
<td>4 feet, 7 feet, 10 feet</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>4</td>
<td>Plug Protection</td>
<td>Transparent Slim boot</td>
<td>Yes / No</td>
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<td>5</td>
<td>Warranty</td>
<td>25-year component</td>
<td>Yes / No</td>
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<tr>
<td>6</td>
<td>Insulation</td>
<td>Flame Retardant Polyethylene</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>7</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
<td>Yes / No</td>
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</table>

### 11.5 UTP Jack Panels

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details</th>
<th>Specification</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>24/48-port, Modular, PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2-1 and IEC 60603-7-4</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>2</td>
<td>Ports</td>
<td>24/48</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>3</td>
<td>Port arrangement</td>
<td>Configured as 6 Port Module with individually replaceable CAT-6 Jacks</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Circuit Identification</td>
<td>Front of each module shall be capable of accepting 9 mm to 12 mm labels</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td></td>
<td>Port Identification</td>
<td>9mm or 12mm Labels on each of 24-ports (to be included in supply)</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>---</td>
<td>---------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Modular Jack</td>
<td>750 mating cycles</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td>Wire terminal</td>
<td>200 termination cycles</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Accessories</td>
<td>Integrated bend-limiting strain-relief unit for cable entry</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Housing</td>
<td>Polyphenylene oxide, 94V-0 rated</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wiring blocks</td>
<td>Polycarbonate, 94V-0 rated</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jack contacts</td>
<td>Beryllium copper, plated with 1.27 mm [.000050] thick gold in localized area and 3.81 mm [.000150] minimum thick tin-lead in solder area over 1.27 mm [.000050] minimum thick nickel under plate</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td></td>
<td>Panel</td>
<td>Black, powder coated steel</td>
<td>Yes / No</td>
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<tr>
<td>10</td>
<td>Approvals</td>
<td>UL listed / ETL Verified</td>
<td>Yes / No</td>
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<td>11</td>
<td>Termination Pattern</td>
<td>TIA / EIA 568 A and B;</td>
<td>Yes / No</td>
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<td>12</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
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### 11.6 FACE PLATE

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<th>Specification</th>
<th>Compliance</th>
<th>Deviation</th>
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<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Single Gang</td>
<td>Yes / No</td>
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<td>2</td>
<td>Material</td>
<td>ABS / UL 94 V-0</td>
<td>Yes / No</td>
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<td>3</td>
<td>No. of ports</td>
<td>One/Two</td>
<td>Yes / No</td>
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<tr>
<td>4</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
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### 11.7 Core Multi-Mode Outdoor Fiber OM2

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<th>Requirement</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cable Type</td>
<td>6-core MM, OM2, Corrugated Steel Armored, Gelly Filled; Loose tube OFC</td>
<td>Yes / No</td>
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<td>2</td>
<td>Fibre Type</td>
<td>50/125um MM</td>
<td>Yes / No</td>
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<td></td>
<td>Specifications</td>
<td>Requirement</td>
<td>Compliance</td>
<td>Deviation</td>
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<td>--------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
<td>Cable Type</td>
<td>6-core, Multimode, 10G Ethernet OM3, Armored, loose-tube, Gel Filled</td>
<td>Yes/No</td>
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<tr>
<td>2</td>
<td>Fiber type</td>
<td>50 / 125, Laser Grade, primary coated buffers</td>
<td>Yes/No</td>
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<tr>
<td>No.</td>
<td>Specifications</td>
<td>Requirement</td>
<td>Compliance</td>
<td>Deviation</td>
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<tr>
<td>1</td>
<td>Fiber type</td>
<td>50 / 125, Laser Grade, primary coated buffers</td>
<td>Yes/No</td>
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</tr>
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<td>2</td>
<td>No. of cores</td>
<td>6</td>
<td></td>
<td></td>
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<td>3</td>
<td>Fiber Attenuation</td>
<td>Yes/No</td>
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<td>@850nm</td>
<td>&lt;=2.7 dB / KM</td>
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<td>@1300nm</td>
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<td>Bandwidth</td>
<td>Yes/No</td>
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<td>@850nm</td>
<td>&gt;1500 MHz-KM</td>
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<td>@1300nm</td>
<td>&gt;500 MHz-KM</td>
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<td>Tensile rating</td>
<td>1000 N</td>
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<td>Yes/No</td>
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<td>Maximum Crush resistance</td>
<td>2000 N</td>
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<td>7</td>
<td>Operating Temperature</td>
<td>-40 Degree C to +60 Degree C</td>
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<tr>
<td>8</td>
<td>Outer Jacket</td>
<td>LSZH</td>
<td></td>
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<tr>
<td>9</td>
<td>Should comply below mentioned standards</td>
<td></td>
<td></td>
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<td>9.a</td>
<td>Fire Propagation</td>
<td>IEC 332-1 and 332-3</td>
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<td>Flammability</td>
<td>IEC 1034</td>
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<td>Smoke Emission</td>
<td>IEC 1034</td>
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<td>Acid Gas Emission</td>
<td>IEC 754-1</td>
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<td>Toxicity</td>
<td>NES 713</td>
<td></td>
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<td>Water Absorption</td>
<td>IEC 811-1-3 (&lt;2mg/cm2 10 days @ 70 Degree C)</td>
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<td>10</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
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<tr>
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<td></td>
<td>Yes / No</td>
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</tbody>
</table>
### 11.10 Fiber Optic LIU with Pigtails, Splice Trays & Splice Protectors (Fully Loaded)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Specifications</th>
<th>Requirement</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Connector Type</td>
<td>SC-Style, Simplex</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>2</td>
<td>Operating temperature</td>
<td>-40 Degree C to +85 Degree C</td>
<td>Yes / No</td>
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</tr>
<tr>
<td>3</td>
<td>Durability &amp; color</td>
<td></td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>MM connectors</td>
<td>500 cycles, Beige</td>
<td>Yes / No</td>
<td></td>
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<tr>
<td>4</td>
<td>SM connectors</td>
<td>220 cycles, Blue</td>
<td>Yes / No</td>
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<tr>
<td>5</td>
<td>Ferrules</td>
<td>Pre-radiused Ceramic Ferrules</td>
<td>Yes / No</td>
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<tr>
<td>6</td>
<td>Attenuation</td>
<td>Not more than 0.75 dB per mated pair</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Fiber Optic Patch panels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>FMS- Front Patching / Splicing Shelf</td>
<td>1U • 19” / ETSI versions available</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The FMS fiber management shelf series is ideal for high density front patching applications.</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Its compact design and high density capacity allows it to deliver carrier class fiber management to central offices, POPs, FTTx, mobile systems and LANs.</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>• High Density:</td>
<td>Yes / No</td>
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<tr>
<td></td>
<td></td>
<td>1U: 12/24 Fiber terminations</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Should be supplied loaded with secondary coated SC pigtails</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mounting brackets can be placed in different positions</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>• Drawer concept allows for</td>
<td>o Easy access to splicing tray</td>
<td>Yes / No</td>
<td></td>
</tr>
</tbody>
</table>
1. Easy access to back side of connector

- Trays with hinges (book type) which allows facilitates easy fiber management and greater access during installation and rework

- Fiber guides, radius controls & secure tie downs provided

<table>
<thead>
<tr>
<th>No.</th>
<th>Specifications</th>
<th>Requirement</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Dimensions</td>
<td>Width - 450 mm &amp; Depth - 280 mm, Height – 44 mm</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Color</td>
<td>RAL 7035 / Black</td>
<td>Yes / No</td>
<td></td>
</tr>
</tbody>
</table>

1.11 SC to SC Patch Cord

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Specifications</th>
<th>Requirement</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Make and Type</td>
<td>SC to SC Duplex Fiber Optic Patch Cord 3 Mtr, 9/125 Micron</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cable Sheath</td>
<td>LSZH</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cable Diameter</td>
<td>2.5 mm twin zip</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ferrule</td>
<td>Ceramic</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Buffer</td>
<td>.9 mm easy strip</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Insertion Loss</td>
<td>MAX .3 db Typical .15 db</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Return Loss</td>
<td>&gt; 45 db</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Temperature Range</td>
<td>-25 Deg. C + 70 Deg. C</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
<td>Yes / No</td>
<td></td>
</tr>
</tbody>
</table>

11.12 SC to LC Patch Cord

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Specifications</th>
<th>Requirement</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Make and Type</td>
<td>SC to LC Duplex Fiber Optic Patch Cords 3m 9/125 micron</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cable Sheath</td>
<td>LSZH</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cable Diameter</td>
<td>1.8 mm mini twin zip</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>S. No.</td>
<td>Specifications</td>
<td>Requirement</td>
<td>Compliance</td>
<td>Deviation</td>
</tr>
<tr>
<td>--------</td>
<td>----------------</td>
<td>--------------------------------------------------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
<td>Make and Type</td>
<td>SC to SC Duplex Fiber Optic Patch Cord 3 Mtr, 50/125 Micron OM2/OM3</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cable Sheath</td>
<td>LSZH</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cable Diameter</td>
<td>2.5 mm twin zip</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ferrule</td>
<td>Ceramic</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Buffer</td>
<td>.6 mm</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Return Loss</td>
<td>&gt; 45 db</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Insertion Loss</td>
<td>MAX .1 db Typical Max .3 db</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
<td>Yes / No</td>
<td></td>
</tr>
</tbody>
</table>

11.14 SC to LC Patch Cord MM

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Specifications</th>
<th>Requirement</th>
<th>Compliance</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Make and Type</td>
<td>SC to LC Duplex Fiber Optic Patch Cord 3 Mtr 50/125 Micron OM2/OM3</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cable Sheath</td>
<td>LSZH</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cable Diameter</td>
<td>1.8 mm twin zip</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ferrule</td>
<td>Ceramic</td>
<td>Yes / No</td>
<td></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>6</td>
<td>Insertion Loss</td>
<td>MAX .3 db</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Return Loss</td>
<td>&gt; 20 db</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Temperature Range</td>
<td>Minus -10 Degree C to +60 Degree C</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>ROHS</td>
<td>ROHS/ELV Compliant</td>
<td>Yes / No</td>
<td></td>
</tr>
</tbody>
</table>

12. Cabinets and Racks:

a.  42 U Floor mounted free Standing cabinets:

42 U Floor mounted cabinets having dimensions H 2013 x W 800 x D 800 mm with reversible front door made of safety glass of thickness 4 mm supplied with cable manager.

Removable side panels fitted with key lock and solid rear door fitted with key lock.

Integrated base with ventilated plate at the front

Solid cable entry plate at the top & bottom

IP 20 as per IEC 60529 with solid sealing.

IK 08 as per NF EN 62262 and IEC 62262

RAL 9002

b.  12 U free corner wall Mounted cabinets:

12U Floor mounted cabinets H 650mm x W 800 mm x D 800 mm with reversible front door made of safety glass of thickness 4 mm supplied with cable manager.

Removable side panels fitted with key lock and solid rear door fitted with key lock.

Integrated base with ventilated plate at the front

Solid cable entry plate at the top & bottom

IP 20 as per IEC 60529 with solid sealing.

IK 08 as per NF EN 62262 and IEC 62262

RAL 9002
D. UPS SYSTEM

1. GENERAL REQUIREMENTS

1.1 The scope of work for supply and installation of UPS system shall include design manufacture, supply, installation, testing and commissioning of all related equipments together with all accessories and auxiliaries as per specifications.

The system shall be fully operational and shall comply to the specified codes and standards.

The contractor shall be responsible for providing all materials, equipments and engineering services specified or which are required to fulfill the intent of ensuring reliability of the total work covered under these specifications within his quoted price.

1.2 Supply and installation of the UPS system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable Standards.


b. IEEE Standard 450-1975 : cable termination on UPS

c. IEEE Paper 4-177 : Some discharge characteristics of lead acid batteries.

d. IEC 60140-3 : UPS Performance

e. IEC 60140-2 : Electro Magnetic Compatibility

f. IEC 60140-1 : Safety

g. ANSI C 37.90a,


h. ANSI C 34.2 : Practices and requirements for semiconductor power rectifiers.

i. ANSI C 37.90 : Relays and relay system associated with electrical power apparatus.

j. NEMA PE-1-1983 : Uninterrupted Power System Standard

k. IS 2208 & IS 9224 : Cartridge fuses for voltages upto and including 650 V

(Part 1 & 2) (I.E.C. 269)

l. IS 9224 (Part - 4) : Fuses for protection of semiconductors.

m. BS 2709 (I.E.C 119) : The Electrical Performance of Semiconductor Rectifiers. (Metal Rectifiers)

n. BS 4417 (I.E.C 146) : Semi-conductor Rectifier Equipments.

o. IS 13947 : 1993 : Specification for Low voltage Switchgear & Control gear
1.3 The contractor shall submit his offer for UPS systems as indicated in the tender document.

1.4 All components of the UPS equipment shall have Surge Withstand Capability (SWC) to meet the requirements of ANSI C62.41-1980. ANSI C 37.90a, IEEE Standard 472-1974.

1.5 All components of UPS system shall withstand short circuit current without any damage.

1.6 Following general requirements shall be met for ensuring proper circuit protection.

a. Fuses shall not be larger than 125% of the transformer primary circuit current where the secondary circuit fuse protection has not been provided.

Where the secondary fuses are sized not larger than 125% of the secondary current of the transformer, fuses shall not be required in the primary circuit, provided the primary feeder fuses are not larger than 250% of the transformer primary current.

b. All the neutral conductors in three phase UPS systems shall be sized equal to at least 150% of the maximum phase current. In addition, all the isolators and circuit breakers used in three phase UPS system shall also rated such that the neutral poles shall take at least 150% of the maximum phase current.

c. All control shall be designed and positioned such that possibilities of inadvertent or accidental operations are eliminated.

d. All UPS system cabinets, frames and power equipment shall be double earthed.

1.7 The UPS design shall ensure that a single component/device failure shall not result in failure of the entire UPS system. The design of UPS System shall be modular to permit easy maintenance.

1.8 The various overload capacities of inverters, static switch, step down transformer/voltage stabilizer as specified herein are the minimum requirements. However, if the Contractor’s offered system has better overload capacities for the above devices, the same shall be highlighted by the Bidder in his bid.
1.9 The UPS system offered by the contractor shall be suitable for operating continuously at the rated capacity indicated in the tender with an ambient temperature of 0-40°C and relative humidity of 0 to 95%. Also, the UPS system shall be suitable for operation as per full rating up to 1000 meters above sea level without derating. The Contractor shall furnish a certificate towards compliance on ambient conditions permissible.

1.10 The UPS system to be supplied by the contractor shall have maximum humming noise level of 69 DB one meter away from the UPS cabinets.

1.11 Suppression of Radio Interference shall be provided to meet statutory requirements.

1.12 Detailed literature should be provided showing Quality Assurance Procedure adhered to.

1.13 The contractor shall submit detailed item by item compliance statement along with the tender.

FUNCTIONAL REQUIREMENTS

2.1 Contractor shall furnish On-Line Uninterruptible Power Supply (UPS) system of continuous duty of the ratings mentioned in the Bill of Quantities. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.

2.2 Contractor shall note that the KVA ratings of the UPS systems shall be guaranteed at 40°C ambient temperature. In case contractor’s standard UPS KVA rating are based at a lower temperature, the contractor must consider a derating factor of at least 1.5% per deg.C for arriving at the specified UPS capacity at 40°C ambient temperature.

2.3 In case the calculated/specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non-standard rating shall not be acceptable.

2.4 UPS system supplied by the contractor shall be the latest state of the art technology system fully digitalized using microprocessor controlled full wave rectification and IGBT inverter.

2.5 Batteries shall be valve regulated lead acid specially meant for UPS application.

2.6 Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.

2.7 The monitoring and control system shall be capable of RS485 with MODBUS protocol input software for connecting to customer’s computer system for data display and monitoring.

2.8 All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Contractor as an integral part of the UPS system.

2.9 The control logic power supply shall have redundant power supply AC input and the system battery as power sources.

2.10 The UPS systems shall include but not be limited to the following equipment:
a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries with guaranteed battery life of 5 years.

b. Suitable factory built battery cabinet for housing the batteries, including terminal isolator / breaker and power disconnect device. The enclosure shall conform to IP 20 as minimum.

c. All cables, connectors, accessories like trunking, cable trays, conduits etc. required for connection between battery and the UPS unit.

3. STATIC CONVERTER

3.1 General

The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction. The converter equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The converter shall be a solid state static PWM converter utilizing Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) transistors and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings.

During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter. The battery shall not be cycled at any time during this step load changes.

3.2 Input Current Limit

The converter logic shall provide input current limiting by limiting the DC output current. Two (2) line-side current transformers shall be employed as a means of sensing the current amplitude. The converter logic shall also be capable of providing auxiliary current limited when the logic is signaled to do so via an external dry contact closure (e.g. UPS fed from generator). The converter shall be capable of supplying overload current in excess to the full load rating. It shall also have sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 95% of full capacity within 10 times the discharge time. The DC output current limit values shall be as follows:

Rectifier output current (maximum) 100%.

Rectifier output current (aux.) 25% - 100% variable.

Note: 100% current shall be under the battery recharging mode.
3.3 Battery Charge Current Limited

The converter logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.

- Battery charge current limit 10% of battery Ah rate.
- Over-current protection at 120% of above item.

3.4 Voltage Regulation

The rectifier / charger output voltage including variation effects of input voltage does not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:

- Form 0 to 100% loading.
- Rectifier input variations of voltage and frequency within the limitations set in Section 3.10.
- Environmental condition variations within the limitations set in Section 3.10.

3.5 Automatic Input Current Walk-in

The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

3.6 Input Overload Protection

The A/C input fuses shall be provided at the converter input as a means of overload protection.

The AC maximum current shall be controlled by the Converter.

3.7 Equalizing Charge Timer

The UPS logic shall provide an electronic automatic equalize charge timer which shall be selectable 24 hours for Lead Acid type or 8 hour for Alkaline type batteries. The timer circuit, once activated shall provide a high rate equalizing charge voltage to the system battery for the selected time. The circuit shall also be capable of manual activation via the LCD touch panel mounted on the front door. The level of equalizing voltage shall be equal to that stated by the battery manufacturer. Upon completion of the timer count, the converter output voltage shall automatically return to the specified float voltage.

3.8 Step Load Change

During any step inverter load change (0-100%), only the converter shall supply 100% current to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

3.9 Input Voltage

The converter shall be fed from the Normal Power Supply source.
The converter shall meet the following specifications in addition to other requirements stated herein:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Voltage</td>
<td>415V, 3 Phase, 3 Wire</td>
</tr>
<tr>
<td>Voltage Range</td>
<td>+15% / -30% AC</td>
</tr>
<tr>
<td>Normal Frequency</td>
<td>50 Hz + 8%</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>+8% (+4 Hz)</td>
</tr>
<tr>
<td>Input Power Factor</td>
<td>0.9 lagging or more at full load (PF improvement)</td>
</tr>
<tr>
<td>Input Harmonic Current THD</td>
<td>3% typical at 100% load</td>
</tr>
<tr>
<td></td>
<td>6% maximum at 50% load</td>
</tr>
<tr>
<td>Duty</td>
<td>Continuous at 40 deg.C</td>
</tr>
<tr>
<td>Cooling</td>
<td>Forced cooling using fans with thermal relays using a latched cut out for re-setting as protection for cooling fans. Each individual fan shall have its own thermal relay.</td>
</tr>
<tr>
<td>Ambient operating temperature range</td>
<td>Operating - 0 to 40 deg.C maximum.</td>
</tr>
<tr>
<td></td>
<td>Storage &amp; Transport -20°C to 70°C</td>
</tr>
<tr>
<td>Operating Relative Humidity</td>
<td>0-95% non-condensing.</td>
</tr>
<tr>
<td>Operating Altitude</td>
<td>Altitude Operating: to 3,000 ft. (1,000 meters) above Mean Sea Level. Derated for higher altitude applications.</td>
</tr>
<tr>
<td></td>
<td>Storage/Transport: to 40,000 ft. (12 200 meters) above Mean Sea Level</td>
</tr>
<tr>
<td>Magnetized sub-cycle in rush current</td>
<td>Typically 8 times normal full load current</td>
</tr>
<tr>
<td>Converter Walk-in time</td>
<td>1 through 60 seconds (every 1 second selectable, (0 to 100% rated load)</td>
</tr>
<tr>
<td>Input</td>
<td>Suitable terminals shall be provided for termination of cables from the AC distribution board.</td>
</tr>
</tbody>
</table>
4. STATIC INVERTER

4.1 General

The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The UPS shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

4.2 Voltage Regulation

The inverter output voltage shall not deviate by more than + 1% RMS due to the following steady state conditions:

- Form 0 to 100% loading
- Inverter DC input voltage varies from maximum to minimum.
- Environmental conditions variations within the limitations set in the section 4.8.

4.3 Frequency Control

The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source or another UPS module) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set hereunder. The inverter shall operate on self run mode without synchronism if the bypass frequency exceeds the set value. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz ± 0.01% (or ± 0.005 Hz). Automatic adjustment of phase relationship between inverter output and standby bypass source shall be gradual at a controlled slew rate which shall be adjustable at the rate of 0.5, 1.0, 2.0, 3.0 Hz / second. (Default 2.0 Hz / second).

The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

a. From 0 to 100% loading.

b. Inverter DC input varies from maximum to minimum.

c. Environmental condition variations within the limitations set in section 4.8.
4.4 Output Voltage Harmonic Distortion

The inverter output shall limit the amount of harmonic content to the values stated in section 4.9. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

4.5 Output Overload Capability

The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 4.8. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

4.6 Inverter Current Limit

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

4.7 Inverter Overload Protection

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.

The inverter fuses shall be the fast acting semiconductor type.

The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

4.8 The inverter shall meet the following specifications in addition to other requirements stated herein:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Input</td>
<td>Three Phase UPS:</td>
</tr>
<tr>
<td></td>
<td>Nominal 360 V DC (Range 290 V to 414 V DC to</td>
</tr>
<tr>
<td></td>
<td>maximum DC bus voltage during charging the</td>
</tr>
<tr>
<td></td>
<td>batteries).</td>
</tr>
<tr>
<td>Nominal Voltage Output</td>
<td>415 V + 1% AC 3 Phase, 4 Wire</td>
</tr>
<tr>
<td>Inverter Capacity</td>
<td></td>
</tr>
<tr>
<td>Voltage Regulation</td>
<td></td>
</tr>
<tr>
<td>a. For 0 to 100% loading</td>
<td>&lt;+ 1%</td>
</tr>
<tr>
<td>b. Inverter DC input voltage vary</td>
<td>&lt;+ 1%</td>
</tr>
<tr>
<td>from maximum to minimum</td>
<td></td>
</tr>
</tbody>
</table>
c. Environmental conditions given below

Transient Voltage Regulation:

a. AT 100% step load change. : <+ 3%

b. At loss or return of AC input. : <+ 1%

c. At load transfer from bypass to inverter. : <+ 3%

Time to recover from transient to normal voltage. : 10 milli seconds

Wave form

a. Normal frequency : 50 Hz

b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled). : + 0.05%

c. Synchronization limits for synchronism between the inverter and standby AC source. : 49 Hz to 51 Hz.

d. Field adjustment range for above : 50 + 0.25 Hz to 50 + 1.5 Hz

4.9 Total voltage harmonic distortion : < 2% THD for 100% linear load

< 4% THD for 100% non-linear load

Duty : Continuous
Cooling: Forced cooling using fans.

Ambient operating temperature range: 0 to 440°C maximum continuous.

Operating relative humidity: 0-95% non-condensing.

Operating altitude: Sea level to 1000 meters.

Output: Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board.

4.10 Built-in Isolation Transformer

This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral, hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighboring installation.

4.11 Reverse Phase Sequence Protection

In the event of phase sequence reversal at the input, UPS system shall continue to work on the main power supply, or UPS systems shall go into battery mode, and shall not trip the UPS system.

4.12 Over all efficiency (AC to AC)

94% at 100% load
92% at 75% load
87% at 25% load

5. UPS BATTERY SYSTEM

a. The UPS system shall, as an integral part, provide battery system for backup time as specified in the Schedule (Full Load) standby capacity.

b. The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating.

c. The battery system shall be sized to provide backup time as specified in the schedule of quantity when the UPS is supplying 100% rated load at 0.8 load power factor.

d. An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.

e. The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar strips and
the entire battery system shall be used in IP20 steel cabinet enclosure and shall be similar to the UPS enclosure.

f. All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.

g. The UPS shall have a properly rated and sized circuit breaker to isolate it from the battery.

6. OPERATION

a. Under normal operation, the UPS load will be fed from the Inverter. The Converter, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.

b. The Inverter shall constantly monitor the AC source frequency and shall be in synchronisation with the AC input source till the frequency of the AC input source is within synchronising limit and if the frequency of the standby source exceeds the synchronizing limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronisation limit, the Inverter shall automatically synchronise itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.

c. Battery Operation:

i. When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilising the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.

ii. If the power failure continues beyond battery back up time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.

7. CONTROL AND MONITORING

a. The UPS shall utilize state of the art full DDC control software driven Control and Monitoring System.

b. It shall be provided with LED displays.

Metering should display the following parameters on the control panel
i. Input AC voltage line-to-line and line-to-neutral for each phase

ii. Input AC current for each phase

iii. Input frequency

iv. Battery voltage

v. Battery charge/discharge current

vi. Output AC voltage line-to-line and line-to-neutral for each phase

vii. Output AC current for each phase

viii. Output frequency

ix. Percent of rated load being supplied by the UPS

x. Battery time left during battery operation.

xi. Bypass power available.

Following alarm messages to be displayed at the control panel:

Input power out of tolerance

Input phase rotation incorrect

Incorrect input frequency

Charger in reduced current mode

Battery Charger Problem

Battery failed test

Low battery warning (adjustable 1 to 99 minutes)

Low battery shutdown

DC bus overvoltage

Bypass frequency out of range

Load transferred to bypass

Excessive retransfers attempted

Static switch failure

UPS output not synchronized to input power

Input power single phased

Input voltage sensor failed
Inverter leg over current in X-phase
Output under-voltage
Output over-voltage
Output over-current
System output overloaded
Load transferred to bypass due to overload
Overload shutdown
Control Error
Critical power supply failure
Load transferred due to internal protection
External shutdown (remote EPO activated)
Fan failure
Over temperature shutdown impending
Over temperature shutdown.

Lamp test.

c. The UPS logic should provide one set of normally open dry contact / relay output to allow interfacing of UPS operating status to an external system and should be capable of providing, as a minimum, 10 numbers status and, should the UPS manufacturer’s standard product does not provide such software, the bidder must add additional equipment and cost for the same.

d. The UPS shall also have an RS485 port with MODBUS interface card if required for interfacing to BAS system or client’s centralized computer network.

e. LCD touch panel (Optional)
i. The UPS shall be provided with a operator friendly large scale LCD touch panel.

ii. The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 200 faults.

iii. The touch screen panel shall clearly define specified areas for operational function, execution and message display.

iv. It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.
v. Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The tenderer should describe in detail the faults that would be displayed under this mode.

8. UPS TESTING

a. The Contractor shall perform the following tests, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator and Measurement Meters etc. shall be the responsibility of the Contractor without any additional cost.

b. The Contractor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Owner.

SPECIFICATION FOR UPS SYSTEM

RATING OF UPS : AS PER BOQ
TYPE : ONLINE

INPUT:
VOLTAGE : 415V ± 15%
FREQUENCY : 50Hz ± 10%

OUTPUT:
VOLTAGE : 415V ±1% (True sine wave)
OVER LOAD CAPACITY : 110% for 20 Minutes
                     125% for 05 Minutes
                     150% for 01 Minutes
FREQUENCY : 50Hz ± 0.05
DC CHARACTERSTICS : DC ripple with battery connected = ± 1 %
OPERATING TEMPERATURE : 40 Degree centigrade maximum 95% Humidity
CABLE ENTRY : Cable entry provision to be given for bottom entry.
BYPASS : Manual bypass to be provided.
PROTECTIONS & INDICATIONS : Standard protections and indications to be provided as required.

No Filter.
THD DATA OUTPUT : Harmonic distortion shall be less than
20% on linear load
5% on non linear loads as per IEC.

CREST FACTOR : Crest Factor should be >3:1. UPS should be parallel upto six units without using any separate synchronization panel.

BATTERIES : Batteries to be sealed maintenance free complete with all the required mounting accessories.

BACKUP TIME : 15 Minutes as per BOQ.

COOLING : Forced Air.

BATTERY CHARGING CURRENT : Vendor to specify.

BATTERY CAPACITY : To be indicated, Calculations to be furnished by the tenderer. Specify VAH.

DIMENSIONS OF UPS & BATTERY : To be filled by the tenderer

OVERALL SPACE FOR MOUNTING ALONG WITH ROOM SIZE. : To be filled by the tenderer.

EARTHING : To be filled by the tenderer.

E. SOLAR SYSTEM

1. SOLAR SYSTEM

1.1 Solar Photovoltaic Module

Standard

Solar Photovoltaic Modules shall conform to UL/ CE / IEC specifications necessary certification from the reputed laboratory shall be provided by bidder.

Electrical Features

Solar Photovoltaic module array shall consist of high efficiency Solar Modules utilizing Crystalline Silicon Solar Photovoltaic cells. Solar Photovoltaic module shall be 170-250Wp. Crystalline high power cells are used in the Solar Photovoltaic module. Solar module shall be laminated using lamination technology using established polymer (EVA) and Tedlar / Polyester laminate.

Each Solar module should consist of 72/60 Photovoltaic cells.

Solar Photovoltaic module efficiency shall be greater than 13%. Module shall be made of high transmissivity glass front surface giving high encapsulation gain and hot butyl rubber edge sealant for module protection and mechanical support.
All materials used must have a proven history of reliable and stable operation in external outdoor applications. Solar modules are designed to operate and perform in relative humidity up to 100% with temperatures between -10 Deg C and +85 Deg C and with stand gust up to 200km/h from back side of the panel.

Sample modules and production processes employed in the manufacture of the offered module are in accordance with the requirements of IEC 61215 / IEC61730.

The module frame must be made of corrosion resistant materials, which is electrolytically compatible with the structural material used for mounting the module.

Module Junction box (weather resistant) shall be designed for long life out door operation in harsh environment.

Degradation of power generated should not exceeding 20% of the min. rated power over the 25 year period. Efficiency of solar PV system shall be guranteed to 90% for above 12 years & 80% for above 25 years.

The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation is compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/material. The encapsulation arrangement ensures complete moisture proofing during life of the solar modules.

Each module must have low iron tempered glass front for strength and superior light transmission. It also must have back sheet for environment protection against moisture and high voltage electrical insulation. The fill factor of modules is not less than 0.70 or above 70%.

Note: I-V curve of each PV module with Sl Nos. should be submitted along with Modules.

Mechanical Features

Solar Photovoltaic Module shall be made of toughened, low iron content, high transmissivity front glass. Anodized Aluminum Frame shall be provide around the module. The module shall be encapsulated with Ethyl Vinyl Acetate (EVA). Silicon edge sealant shall be provided around laminate. The back surface shall be Tedlar /Polyester trilaminate. ABS plastic terminal box shall be provided for the module output termination with gasket to prevent water moisture. the module shall be Resistant to water, abrasion, hail impact, humidity & other environment factor for the worst situation at site. Bypass diode arrangement shall be provided.

1.2 Thin Film Solar Photovoltaic Module

Standard

Thin film Solar Photovoltaic Modules shall be certified for IEC 61646, IEC 61730 and UL 1703 necessary certification from the reputed laboratory shall be provided by bidder.

Construction

Thin film solar modules shall be state of the art and fully automated. The frameless glass-PVB-glass modules shall be available in quarters, half and full size configurations offering a range of power output. These modules shall be ideal for large grid- connected photovoltaic system. Thin film module shall be
based on single junction Amorphous Silicon (a-Si) technology. Module shall be available in from stabilized power of 78W to 88W. Module shall have frameless Glass –PVB- Glass module with highly translucent and low iron front glass. Modules shall be available with the option of bonded black rails. PV module shall be made from non-toxic materials and recyclable.

Performance

Thin Film PV module shall be capable of deliver stabilize power with higher efficiencies. Module shall perform under a diverse set of climatic conditions (i.e. under diffuse light and indirect sunlight condition). Thin film PV modules shall have high reliability and quality modules. Modules shall have provision for inspection of mechanical & visual defects with continued monitoring of electrical performance. Operating temperature for modules shall be from -40 deg C to +85 deg C.

1.3 Data Sheet For The Solar Pv Module Shall Be Furnished By Vender

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<td>PV Module Manufacturer name &amp; Country</td>
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<td>ii.</td>
<td>PV Module type</td>
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<tr>
<td>iii.</td>
<td>No. of PV cells per Module</td>
</tr>
<tr>
<td>iv.</td>
<td>Mounting arrangement for Solar module</td>
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<tr>
<td>v.</td>
<td>Solar module frame material</td>
</tr>
<tr>
<td>vi.</td>
<td>Module Overall dimensions (mm)</td>
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<td>vii.</td>
<td>Cable gland at module Junction Box</td>
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<td>viii.</td>
<td>Weather resistant HDPE junction Box (IP55)</td>
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<td>ix.</td>
<td>Max. Temperature rise of solar cells under severe working conditions over Max. Ambient Temp.</td>
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<td>x.</td>
<td>Nominal voltage</td>
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<td>xi.</td>
<td>Operating voltage of solar module (nom)</td>
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<td>xii.</td>
<td>Peak power voltage (Vmp) at standard test conditions</td>
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<td>xiii.</td>
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<td>xv.</td>
<td>Short circuit current (Isc)</td>
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<tr>
<td>xvi.</td>
<td>Weight of each module</td>
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<tr>
<td>xvii.</td>
<td>Standards / Approvals from International Agencies</td>
</tr>
<tr>
<td>xviii.</td>
<td>Cell Type</td>
</tr>
</tbody>
</table>
1.4 Module Mounting Structure

Structure shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to
the roof properly. There shall be no requirement of welding or complex machinery at site. The array
structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV
panels & shall withstand heavy winds. The supplier / manufacturer shall specify installation details of the
PV modules and the support structures with appropriate diagrams and drawings.

Module mounting structure shall be made up of aluminium. Super structure shall be designed &
fabricated according to site condition.

Support structure design and foundation or fixation mounting arrangements should withstand minimum
horizontal wind speed of 200kms / hr (Designed value shall be greater than 200kms /hr). All fasteners
shall be of Stainless steel - SS 303.

1.5 Junction Boxes

The junction boxes shall be dust free, vermin and waterproof and made of FRP / Thermo Plastic with
IP65 protection. The terminals shall be connected to copper bus bar arrangement of proper sizes. The
junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for
both incoming and out going cables. Suitable markings shall be provided on the bus bar for easy
identification and cable ferrules shall be fitted at the cable termination points for identification.

The junction boxes shall have suitable arrangement for the following:

Combine groups of modules into independent charging sub-arrays that shall be wired to the controller.

Provide arrangement for disconnection for each of the groups.

Provide a test point for each sub-group for quick fault location.

To provide group array isolation.

The rating of the JB’s shall be suitable with adequate safety factor to inter connect the Solar PV array.

Metal oxide arrestors shall be provided inside the Array Junction Boxes.

1.6 Power Conditioning Unit (Pcu)

Solar array shall produces DC energy output and supplied to the DC buse. Maximum Peak Power
Tracking (MPPT) (The efficiency of PCU shall not be less than 95% & shall be designed to meet the Solar
PV Array capacity control) will extract maximum energy from solar array and provides 24VDC +/-5%
50HZ. PCU should have 150 % Over load capacity for 60sec. Output wave shape shall be sine wave with
< 3% total harmonic distortion (THD). Additionally, it will provide protection features such as, over current, short circuit, over temperature as a minimum. PCU shall be of very high quality having high efficiency and shall be capable of running load in isolated mode. The PCU shall be string type inverters to reduce the DC power losses & can have the flexibility to increase the capacity of the plant. The PCU shall be designed for continuous, reliable power supply as per specifications. The PCU shall have internal protection arrangement against any sustained fault. The dimension, weight, foundation details etc. of the PCU shall be clearly indicated in the detailed technical specification. It has user friendly LCD display for programming and view on line parameters. Unit shall be IP-65/67

1.7 Reference Data Sheet for Power Conditioning Unit Vendor to Submit their Data Sheet.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Typical Electrical Parameters</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Nominal Power at STC, Pmax</td>
<td>W</td>
</tr>
<tr>
<td>ii.</td>
<td>Power tolerance at STC (min/max)</td>
<td>%</td>
</tr>
<tr>
<td>iii.</td>
<td>Voltage at Pmax, Vmp</td>
<td>V</td>
</tr>
<tr>
<td>iv.</td>
<td>Current at Pmax, Imp</td>
<td>A</td>
</tr>
<tr>
<td>v.</td>
<td>Open circuit voltage, Voc</td>
<td>V</td>
</tr>
<tr>
<td>vi.</td>
<td>Short Circuit Current, Isc</td>
<td>A</td>
</tr>
<tr>
<td>vii.</td>
<td>Nominal Operating Solar Cell temperature(NOCT)</td>
<td>Deg C</td>
</tr>
<tr>
<td>viii.</td>
<td>Maximum System voltage</td>
<td>V DC</td>
</tr>
<tr>
<td>ix.</td>
<td>Temp. Coefficient of Pmax</td>
<td>% /K</td>
</tr>
<tr>
<td>x.</td>
<td>Temp. Coefficient of Voc</td>
<td>% /K</td>
</tr>
<tr>
<td>xi.</td>
<td>Temp. Coefficient of Isc</td>
<td>% /K</td>
</tr>
<tr>
<td>xii.</td>
<td>IP protection Level</td>
<td></td>
</tr>
<tr>
<td>xiii.</td>
<td>Absolute Maximum Ratings</td>
<td></td>
</tr>
<tr>
<td>xiv.</td>
<td>Operating Temperature</td>
<td>Deg C</td>
</tr>
<tr>
<td>xv.</td>
<td>Storage Temperature</td>
<td>Deg C</td>
</tr>
<tr>
<td>xvi.</td>
<td>Mechanical Parameters</td>
<td></td>
</tr>
</tbody>
</table>

1.8 Data Monitoring of Power Plant

The performance and generation data is recorded using a data logger. The Monitoring system shall comprise of the following main components:
PCU logs the inverter performance data and transmits the same to the Data logger.

Data logger gathers information and monitors the performance of the inverter. It also supports measurements from the external sensors. The data can be acquired remotely via a modem.

PC Data logging software enables automatic long-term storage of measured data from PV-Plant. It allows visualization, monitoring, commissioning and service of the installation.

Communication interface the entire system can be operated and monitored via several interfaces (RS232/RS485/ MPI/ Profibus/ Telephone modem/Ethernet), in addition to the information indicated on the operator panel. Further information can also be acquired remotely through the interfaces mentioned above.

1.9 Static Inverter

The static inverter shall be of solid state. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The system shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

The inverter output voltage shall not deviate by more than + 1% RMS due to the following steady state conditions:

- Form 0 to 100% loading
- Inverter DC input voltage varies from maximum to minimum.

The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

The inverter output shall be capable of providing an overload current. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be drop-out.

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.

The inverter fuses shall be the fast acting semiconductor type.

1.10 Ups Battery System

The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating. The battery system shall be sized to provide backup time of minimum 6
hours. An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.

The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar.

All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.

1.11 Cables and Accessories

1.11.1 All the cables shall be supplied conforming to IS 694 & shall be of 650 V/ 1.1 kV grade as per interconnections, array to junction boxes, junction boxes to DCDB, DCDB to PCU etc shall be so selected to keep the voltage drop and losses to the minimum.

1.11.2 Bidders are required to mention each size of cables used and should consider their resistance/impedance in the design optimization. Such calculation should be submitted along with the bid.

1.11.3 The contractor shall supply all installation accessories, which are required to install and successfully commission the power plant.

1.12 Earthing and Protection

The array structure of the PV yard shall be grounded properly using adequate number of earthing kits. All metal casing / shielding of the plant shall be thoroughly grounded to ensure safety of the power plant. Earthing shall be in line with IE rules. Detailed specifications have been provided in the Earthing section.

1.13 Bill of Materials

1.13.1 Complete Bill of Materials inclusive of Solar PV Modules, array Junction box, main junction box, cables, PCU, Module mounting structures, etc shall be provided along with the offer. The numbers of each component proposed for supply shall be clearly specified.

Solar Array Capacity-
Module mounting clamps/structure-
Power Conditioning Unit-
Data Logging system-
Inverter system
Battery bank
Junction Boxes-
Cable & Earthing material-
Distribution Panels

1.13.2 The items not listed in BOM but required for successful installation / commissioning of SPV Power plant shall also be considered to be part of the supply scope without any extra cost to the owner.

1.14 Spare Parts

Bidder shall mention recommended spares and also furnish details for shares parts at least 3-5 years of their nearest service center.

1.15 Type Test

Type testing certification should be produced at the time of delivery or earlier. Type test certification should be dated not earlier than 1 year.

1.16 Installation and Commissioning

1.11.1 Detailed project execution program shall be submitted along with the offer. The bidder will be responsible for arranging all tools & plants for installation and commissioning the complete system.

1.11.2 The bidder will also submit the erection, testing & commissioning procedure for approval to the owner. These procedures will form integral part of the acceptance report for successful erection and commissioning the system. These reports will be prepared and signed by the bidder or his representative & the officials of the Purchaser concerned with project.

1.17 Support/ Training

The contractor must agree to provide complete support as per site requirement (single point of contact regarding for entire solutions). Contractor shall provide the on site 3 day basic operation & maintenance training to owner’s staff in 2 schedules.

Contractor shall provide the operations and maintenance staff for first month in two shifts at site. The O&M staff provided for first month at site should be able to take care the fault finding and repair system to maintain the desired level of uptime of solar solutions at site.

2. COMMISSIONING & GUARANTEE

2.1 Scope of Work

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Tenderer shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Tenderer shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Client / Consultant / Project manager or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before preforming any test.
Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2.2 Pre commissioning

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Owner’s site representative.

Wiring continuity test.

Insulation resistance test.

Earth continuity test.

Earth resistivity test.

Test as per Appendix ‘E’ of IS:732 -1989

2.3 Statutory Authorities’ Tests And Inspections

As and when notified in writing or instructed by the Client/ Consultant / Project Manager, the Tenderer shall submit drawing and attend all tests and inspections carried out by Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Tenderer shall make all allowances in this respect.

The Tenderer shall be responsible for the submission of all necessary forms and drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Consultant for checking before submission.

The Tenderer shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Client/Consultant/ Project Manager may at his discretion instruct the Tenderer for additional submissions to the Local Authorities whenever necessary.

The Tenderer shall notify the Client/ Consultant/ Project manager at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Tenderer shall inform the Architect/Consultant without delay.

2.4 Final Acceptance Tests

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Tenderer shall carry out final acceptance tests in accordance with a programme to be agreed with the Consultant / Client.
Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Tenderer shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Tenderer prior to the issue of Completion Certificate to the acceptance of the Authorities.

2.5 Rejection of Installation / Plant

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, and erection or on completion at site may be rejected by the in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Client/ Consultant/ Project Manager so as to comply with the Authority’s requirements and the intent of the Specification shall be carried out by the Tenderer at his own expense and to the satisfaction of the Authority/Consultant.

After works have been accepted, the Tenderer may be required to carry out assist in carrying out additional performance tests as reasonably required by the Client/ Consultant/ Project Manager.

2.6 Warranty and Handover

The Tenderer shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

2.7 Handing Over of Documents

All testing and commissioning shall be done by the Tenderer to the entire satisfaction of the /Services Consultant and all testing and commissioning documents shall be handed over to the Services Consultant / Client/ Project Manager.

The Tenderer shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Services Consultant / Client/ Project Manager.

F. GAS SUPPRESSION SYSTEM

GENERAL

System includes Supply, Installation, Testing and Commissioning of FK-5-1-12 (Dodecafluoro-2-Methylpentan-3-one), Novec-1230 or equivalent gas Suppression system in accordance with the Contract Documents.

Scope of Work:

Supply, Installation, Testing and Commissioning of clean Agent (Novec 1230 or equivalent) Fire Suppression system designed to provide a uniform concentration within the electrical panels in accordance with NFPA 2001 and requirements of the contract documents).
Provide all engineering design and materials for a complete agent suppression system including FK-5-1-12 storage cylinders with steel bracket, extinguishing agent, detection tube, cylinder valve and associated accessories including but not limited to; adaptors, pressure switch, tube fittings etc, required for complete operation of system.

All necessary safety requirements such as warning signs, discharge alarm shall be part of system.

The necessary nomenclature such as pressurization level, agent volume, gross/net weight of cylinder shall be clearly marked on cylinder.

Prior to supply of material at site. Contractor must submit following documents for approval of Engineer-in-charge.

Drawing in A-4 size, clearly showing the panel, routing of tube inside the panel, location and fixing arrangement of cylinder & system components.

All doors and holes in the enclosed/equipments should be closed or sealed to maintain the tightness of enclosure.

1.2 System Description:

The detection tube shall be fixed with cylinder valve at top of cylinder. The tube shall be pressurized with dry nitrogen. In case of reach of pre-determined temperature (100-120oC), the tube shall rupture gas shall be released from tube over the protected area.

The pressure switch shall be provided for necessary indication of discharge of gas.

The Extinguishing Agent shall be stored in cylinder as liquefied compressed gas, super pressurized with dry nitrogen at 195 psi.

The cylinder shall be equipped with brass valve, pressure gauge (to monitor agent pressure) and isolation valve for maintenance purposes. The cylinder bracket shall be of steel construction with quick release clamp.

The detection tube shall be installed throughout the compartments of panel. The location and spacing of tube shall be above the hazard, to be protected.

In case of fire, the tube shall rupture at a point. The rupture of tube shall result in formation of discharge point and release the agent in uniform pattern.

With system activation, a signal should be generated via Audio Visual Alarm installed at convenient location as per Engineer-in-Charge.

2. System Components:

The bidder shall provide an under taking from Principle Manufacturer of CE marked product they intent to install, that manufacturer will fully support the bidder for this specific project.

Cylinder of steel construction with standard red epoxy paint finish. Cylinders shall be accompanied by original manufacturers test certificate confirming the contents of the cylinder.
The cylinders shall be from reputed Manufacturers only. Cylinders shall be super pressurized with dry nitrogen to an operating pressure and temperature as per manufacturer recommendations.

Each cylinder shall have pressure gauze and low pressure switch to provide visual and electrical supervision of the cylinder pressure. The low pressure switch shall be wired to the Audio Visual Alarm to provide audible and visual trouble alarm in the event of drop of pressure. The pressure gauze shall be color coded to provide an easy, visual indication of cylinder pressure.

Furnish a welded steel bracket with each cylinder assembly for holding the cylinders in a saddle with a front bracket piece that secures the cylinders.

Cylinder shall be provided with a certificate provided by the company who charge with the FK-5-1-12 gas mixture. The certificate shall be secured around the cylinder with chain fastener.

The Detection Tube, LPCB/UL/CE approved to be Red Colour and pressurized at 195 Bar. The Detection Tube to rupture between (100-120°C).

The Pressure Switch should be CE Marked having NO/NC contact.

The cylinder should be constructed as per BIS Standard as per IS 15683 specification.

3. Extinguishing Agent

FK-5-1-12 (Dedecafluoro-2-Methylpentan-3 One – CF2CF2C (O) CF (CF3)2

The agent shall not contain any Hydro fluorocarbons (HFC).

The ozone depletion potential should be zero.

The Global warming potential should be equal to or less than 1.

The Extinguishing Agent should be UL Listed/ FM approved.

The extinguishing agent should be filled in an UL Listed or FM approved filling station.

Installation

The system shall be installed on basis of approved drawing.

The installation / final connections shall carry out in direct supervision of representative of Manufacturer/authorized distributors.

The installation contractor should be a proven source with minimum 5 years of installation of Trace Tube Systems in India.

Cylinder shall be located so that they are not subjected to mechanical, chemical or other damage.

All system components shall be capable of withstanding heat of fire and severe weather conditions.

Detection Tube to be properly secured inside the panel by Clips/Tie etc.

The Detection Tube outside the panel should be protected in flexible conduit.
Inspection certificate should be pasted on cylinder clearly marking next due date of inspection.

G. DG SYSTEM

1. GENERATORS

1.1 SCOPE

The scope of this section consists of but not necessarily limited to the following:

a. The contractor shall supply, deliver to site, hoisting into position, install, test and commission the standby power generating set together with the necessary controls and switchboards as specified and indicated in the Drawings. Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided without any additional cost to complete the system.

b. Provide manufacturer’s factory representative’s services, including coordination, start-up and testing supervision at site.

c. Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.

d. Carry out performance test run at site.

1.2 Submission

For bidding

The bidder shall submit offer with the following documents in two sets.

- Schedule of deviations from technical specifications.
- List of proposed makes, for the items listed in the tender.
- Technical datasheets indicating overall dimensions & Catalogues of major items, highlighting the offered models.
- Design drawing of residential silencer.
- Day oil tank detailed design drawing.
- Structural support drawings.
- To submit power controller (AMF/Synchronizing module) drawings along with operation logic.
- Supporting structure details of chimney e.t.c.
- Other documents and comments, if any.

For approval before construction/erection

The Sub-contractor shall submit the following documents.
For all the supplies, the sub-contractor shall submit the following documents in 4 sets for approval.

General arrangement drawings, with all dimensions, showing: space-requirements, weights (for transport and service conditions), requirements of civil works/foundation, fixing and mounting facilities, connection devices, etc.

- Electrical drawings, showing: power and control single line and functional/control multi line diagrams, terminal blocks, components’ list with make, type, quantity, etc.

Quality assurance plan and bar-chart showing manufacturing schedule.

The sub-contractor shall incorporate all comments and submit revised drawings in stipulated time till all drawings are finally approved for manufacturing.

Final

The sub-contractor shall submit the following documents, reflecting the true final as built situation, in 6 sets, and one soft copy in CD.

The drawings including wiring diagrams as revised and “as built”.

Inspection and preliminary testing certificates and reports and shipping release.

Test certificates of kWh meters from Government approved Lab or Electric Supply Co. of concerned area.

Guarantee certificates.

Instruction & maintenance manuals, Cataloguers etc.

Any other certificate / report as called for by the Client / Consultant.

1.3 Product

1.3.1 Capacity

Actual power output shall be as shown in drawings and in schedule of quantities.

Diesel Engine

The diesel engine shall be of the 4 stroke cycle, prime, power rating (prime as specified in BOQ), multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply Center / State Pollution Control Board and shall conform to BS:649/559.

The engine shall be complete with Radiator cooled engine, lubricating oil pump, lubrication oil pressure gauge, tachometer, digital or electronic type governor, integrated hours-run recorder, overspeed trip and all other necessary auxiliaries.

The brake horse power of the engine with all attached accessories as specified shall not be less than that which is required by the full load rating of the alternator at site operating conditions taking into consideration losses, plus a reserve factor of at least 10%.
1.3.2 Starting

Starting system of the standby generator shall be of a heavy-duty electric motor complete with a 24 V D.C. heavy-duty battery. The electric motor shall be capable of cranking the engine to achieve the rated speed in less than 10 seconds from the initiation of the starting process. The electric start battery shall be of adequate capacity for 3 successive starts. Time delay relays shall be incorporated to provide a rest period of 1-5 seconds (adjustable) before each successive start and a time lag period of 19-100 seconds (adjustable) before the system lock out due to failure of the 3rd start to crank up the engine.

The generator set shall be provided with a micro-processor based control system which is manufactured to provide automatic starting, monitoring, and control functions for the generator set. Interface to BMS system according to point schedule on drawings shall be provided.

The control system shall include an engine governor control, which shall function to provide steady state frequency regulation. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

1.3.3 Speed Regulation

The governor shall be capable of regulating the speed of the engine within the limits approximately 10% of the rated speed within 4 seconds due to a sudden application or removal of a full load. The steady load speed shall vary within the limits of approximately 1% of the rated speed.

1.3.4 Cooling

The engine cooling system shall be of radiator type system to cool the engine as well as the body to minimise heat radiated into the generator room. The cooling circuit shall exchange heat through a heat exchanger capable to remove the heat generated under continuous full load operation.

1.3.5 Lubricator

The lubricating system shall be by a positive displacement oil pump providing a positive force feed to all lubricating points.

1.3.6 Exhaust System

Adequate sized piping and fittings shall be installed to carry the engine exhaust discharge into the atmosphere at a height as indicated in the drawings & as per the requirement of Center / State Pollution Control Board or Pollution Control Committee as the case may be.

Galvanized M.S. structural support and vibration arrestors for D.G. set chimney to specify along with drawing for statutory clearance.

Mufflers shall be installed to reduce the engine exhaust noise to a maximum of 5 dBA above ambient noise level at nearest area accessible to the public within 3m from Generator Room and at least 2m above floor level. Flexible connection shall be provided between the engine and the fixed piping.

1.3.7 Fuel Piping and Fuel Tank Installation
The complete system shall include engineering, supply, installation, testing and commissioning of tank for storage of fuel, pumps, piping, valves and control system.

1.3.8 Instruments

An instrument panel mounted on the engine shall be provided and shall comprise the following flush-mounted instruments and gauges:

- Lubricating oil inlet and outlet temperature
- Lubricating oil pressure gauge
- Tachometer, positive driven
- Hour counter.

1.3.9 Protection Devices

Warning indication and automatic shut-down shall be provided for the following:

- Low oil pressure shutdown and alarm
- Low and high coolant temperature alarm
- High coolant temperature shutdown
- Fail to crank shutdown
- Overcranking shutdown
- Overspeed shutdown
- Low & high DC voltage alarm
- Low battery alarm
- Low fuel-day tank alarm
- High and Low AC voltage shutdown
- Under frequency shutdown
- Over current and alarm and shutdown
- Short circuit shutdown
- Ground fault alarm
- Overload alarm
- Emergency stop

Failure indication lights and alarm for all fault conditions shall be provided on control panel for restoring the operation to normal.
The starting circuit shall be disconnected in the event of any of the above shutdowns.

1.3.10 Alternator

The alternator shall be brush less synchronous drip proof, self-ventilated and screen-protected and directly coupled on to the diesel engine by flexible coupling and shall be continuously rated for site operating conditions and conform to BS 5000 (part99) or IS 4722.

The full load output voltage shall be 415 volts, 3 phase, 4 wire, 50 Hz at 0.8 power factor with neutral solidly earth with the frequency maintained at 50 Hertz at all time under any load condition including transient overload due to motor starting etc.

The rotor shall consist of the main alternator field poles the brushless exciter and its rectifier module, all bolted on a common alternator shaft. The rotor shall be mechanically and electrically balance up to 135% of the rated speed. The insulation of the alternator shall be non-hygrosopic, Class “H” on the exciter, Class “H” on the stator and Class H on the rotating pole pieces.

The rectifier module of the exciter shall be impregnated with epoxy resin and shall be capable of withstanding without damage or deterioration of the thermal, centrifugal and other stresses that is experienced during normal or short circuit conditions. Rectifiers shall be of silicon type.

The voltage build up shall be of self-excitation using the residual voltage of the alternator through a solid-state voltage regulator. The voltage regulator shall be capable of maintaining the voltage regulation to ± 1% independent of power factor, heating and 5% of speed variation. The voltage output of the alternator shall also be capable of manual adjustable to ± 5% of the rated voltage.

The response of the voltage regulator shall be less than 10 millisecond. The voltage dip shall not exceed 15% when a rated continuous load is supplied to the unloaded alternator and the correction time shall not exceed 200 millisecond. When the rated load is withdrawn, the voltage overshoot shall not exceed 20%.

The automatic voltage regulator and the exciter shall be manufactured to withstand 50% overload at a constant terminal voltage.

A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of motor current for not more than 10 seconds.

1.3.11 Generator Control Panel

The generator control panel shall have all necessary instruments and accessories for operation and control of the generating set. On sensing the utility mains voltage dip to below said voltage, the control panel shall send a signal to start the generator. After 3 successive start and if the diesel generator is not started up, the alarm signal shall be activated.

The generator control panel shall consist of all Synchronizing system, circuit breakers, protective relays if applicable and accessories required to control the generator operation and shall include but not limited to the following:
Voltmeters

Ammeter
Frequency Meter
Power factor meter
Kilowatt meter with maximum demand indicator
Kilowatt hour meter
Hour run meter
Start-stop and automatic mains monitoring system
Emergency off push button
Manual speed adjusting control reset for overload, alarm muting.
Fully automatic trickle battery charger with voltmeter.
Audio and visual (flashing) alarm.
The start-stop and automatic mains monitoring system shall be equipped with the following:
Duty selector switch for ‘off-automatic-test-manual’ operation.
Manual start-stop push button switch
Manual alternator circuit breaker ‘On-Off’ switch
Cancel alarm switch
Reset switch
Indicating lamps
Battery Status

1.3.12 Interface With Building Automation System

All necessary hardware’s / software’s to integrate the Generator microprocessor panel to BAS system shall be provided free of cost by generator manufacturer / supplier.

For the integration of Microprocessor Panel of the generator with the Building Automation System, an Interface Control Document shall be developed by BAS Contractor. It shall be responsibility of Generator Contractor to provide following to BAS Contractor for preparing the interface.

a. Hardware Protocol of Microprocessor panel.
b. Software Protocol of Microprocessor panel.

c. Communication structure relating to collection of message / event information.

d. Description of the formatted packets / blocks of data which construct controller commands / responses.

e. Written permission to BAS contractor to develop the interface without any financial implication.

1.3.13 Acoustic Treatment

All DG sets up to 1000 kVA shall be provided with its own outdoor type acoustic enclosure duly tested and approved for 75 dBS as per norms of central / local pollution control board.

A. ACOUSTIC ENCLOSURE FOR DIESEL GENERATOR

Acoustic Enclosure for DG Set shall be as given below:

DG Set Capacities : 600 kVA
Structure : MS Press bend 3 mm
Panels : Steel fabricated double wall insulated panels.
Thickness of panels : 100 mm thick
Outer sheet : 2 mm thick CRCA sheet steel
Inner Sheet : 1.25 mm thick CRCA Perforated sheet steel
Frame & Strainer : 2 mm thick CRCA sheet steel
Insulation : Mineral wool as per IS 8183 - 1993
Thickness : 100 mm thick (50 mm x 2 slabs)
Density : 64 Kg / m3
Anti-Droning : HDPE sheet
Thickness : 6 mm thick
Air Circulation System : Ventilation system of suitable capacity required for each DG Set offered suitable ducted exhaust arrangement for fresh air intake and exhaust shall be made to avoid short cycling
Finishing : Powder coating of colour shade approved by consultant / owner.
Noise Level : 75 dBA at a distance of 1.0 meter.
Location : Indoor
Δ T Acoustic Enclosure : Should not exceed from 7 degree C above ambient temperature.

Painting of Exhaust Piping : High temperature aluminium paint shall be used (600 – 700 deg C) for painting of unclad exhaust pipe and top of the chimney

Base frame for canopy : Powder coated as per approved colour

Lighting : Proper lighting shall be made inside the acoustic enclosure for maintenance purpose.

1.3.14 Battery Charger

1.3.9.1 General

The battery charger shall be Float cum Boost type IGBT controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

1.3.9.2 Construction Feature

The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5. Four wheels shall be provided at the base.

1.3.9.3 Performance

The D.C output voltage of Float / Boost charger shall be stabilized within + 2% for AC input variation of 230 V + 10%, frequency variation of 50 Hz + 5% and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response IGBT control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

1.3.9.4 Components

The battery charger shall essentially comprise of the following

1 No. double pole ON/OFF MCB at AC input.

1 No. pilot lamp to indicate charger ON.

1 No. Main Transformer : Double wound, naturally air cooled, having copper winding.
1 set single phase full wave bridge rectifier consisting of 4 Nos. IGBTs, liberally rated, mounted on heat sinks and complete with resistor / condensor network for surge suppression.

1 No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.

1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at + 2% of time set value for AC input voltage variation of 230 V + 10%, frequency variation of + 5% from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.

1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.

1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.

1 No. moving coil DC voltmeter to read the DC output voltage.

2 set potentiometer to adjust the output voltage during manual /auto float and boost modes.

2 No. double pole ON/OFF MCB at DC output, 1 No. at charger output and the other at load.

2 set DC output terminals. 1 set for the load and the other set for the battery.

Alarm Annunciation : Visual and audible alarm with manual accept reset facility shall be provided for the following for BMS Connectivity

a. AC mains fail
b. Charger Fail
c. Load / Output overvolt.

1.3.9.5 Rating

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Input</td>
<td>230 V + 10% AC 50 Hz single phase.</td>
</tr>
<tr>
<td>DC Output</td>
<td>To float / boost charge batteries and also supply a continuous load.</td>
</tr>
<tr>
<td>Current Rating</td>
<td>30.0 Amps</td>
</tr>
<tr>
<td>Float Mode</td>
<td>27.0 V nominal (Adjustable) between 24-28.0 V.</td>
</tr>
<tr>
<td>Boost Mode</td>
<td>29.0 V nominal (Adjustable) between 24-32.0 V.</td>
</tr>
<tr>
<td>Voltage Regulation</td>
<td>+ 2% for AC input variation of 230 V + 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100%</td>
</tr>
</tbody>
</table>

1.3.9.6 Performance Tests
The schedule of tests to be performed in the Factory Acceptance Test shall include the following:

On each of three separate days and before any other operation of the diesel-alternator on that day three successful manual start-up operations to be accomplished.

Three separate manual start-up operations each within one minute of the diesel-alternator being shut down after running continuously for not less than one hour and attaining normal engine running temperatures.

Three separate automatic start-up operations with simulation of “mains failure”. In all or any of these tests the diesel-alternator may be out on load by the automatic closing of the emergency power supply circuit breaker.

Three separate automatic shutdown operations, each initiated by mechanical simulation of a “low pressure” condition.

Three separate automatic shutdown operations, each initiated by manual instigation of an “over-speed” condition.

Three separate abortive start-up operations, each inducing “failure to start” shut-down.

The load tests shall be carried out as follows:

- Idle Run 5 mins
- 25% of full load at 1.0 pf For half hour
- 50% of full load at 1.0 pf For one hour
- 100% of full load at 1.0 pf For two hours
- 110% of full load at 1.0 of For one hour

At the completion of the test, readings shall be taken of Voltage, Frequency, Current, Temperature, Vibration, Fuel ratio to Unit produced, Flue analysis and the following:

- Insulation resistance – rotor, stator, exciter – to earth;
- Insulation resistance – between stator windings;
- Alternator rotor and exciter armature temperature

1.3.9.7 Site Test

Upon the delivery to the site and if the generator set is required to re-assemble on site, similar tests shall be carried out by the Contractor to ensure that the performance is not degraded.

The tests, but not limited to are:

- Diesel engine-Generator coupling and shafts alignment
- On load ‘mains failure’ simulation test
Safety devices test
Remote monitoring
Auxiliary contacts etc.
Load tests.
BMS interface test

Load tests may be carried out through building load and/or Contractor load bank. Cost to arrange for the load for purpose of testing shall be included in the Tender.

1.3.9.8 Painting of Pipe Work

All pipe work, other than buried pipes, shall be painted immediately after installation with at least one coat of red primer and two (2) finishing coats of best quality aluminum paint. The colour will be determined by the Project Manager on site.

1.3.9.9 Vibration Control

The complete generator assembly shall be isolated on static deflection unhoused spring-neoprene in series isolator with non-skid neoprene pads. Start-up and shut down rocking restraint snuffers shall be provided at four corners of base frame.

All fuel line pipes shall be cushioned with a layer of harnesses and neoprene pad at attached points.

All pipe work and engine silencers shall be suspended on static deflection spring-neoprene in-series hangers.

Detail calculation and proposal for justifying the size and provision shall be provided for Project Manager review prior to the installation.

1.3.15 EMISSION STANDARDS FOR DIESEL ENGINES (ENGINE RATING BELOW THAN 800 KW) FOR GENERATING SET

G.S.R.771(E) – In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:—

a. i. These rules may be called the Environment (Protection) (Third Amendment) Rules, 2013.

ii. They shall come into force on the date of their publication in the Official Gazette.

b. In the Environment (Protection) Rules, 1986, in Schedule I, for serial number 95 and entries relating thereto, the following serial number and entries shall be substituted, namely:-

“95, Emission limits for new diesel engine up to 800 kW for generator set (Genset) application.- The emission limits for new diesel engine upto 800 kW for generator set (hereinafter referred to as Genset)
application shall be effective from 1st April, 2014 as specified in the Table below subject to the general conditions contained therein, namely:-

<table>
<thead>
<tr>
<th>Power Category</th>
<th>Emission Limits (g/kW-hr)</th>
<th>Smoke Limit (light absorption coefficient, m-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOx + HC</td>
<td>CO</td>
</tr>
<tr>
<td>Upto 19 KW</td>
<td>≤ 7.5</td>
<td>≤ 3.5</td>
</tr>
<tr>
<td>More than 19 KW upto 75 KW</td>
<td>≤ 4.7</td>
<td>≤ 3.5</td>
</tr>
<tr>
<td>More than 75 KW upto 800 KW</td>
<td>≤ 4.0</td>
<td>≤ 3.5</td>
</tr>
</tbody>
</table>

Note: 1. The abbreviations used in the Table shall mean as under: NOx – Oxides of Nitrogen; HC – Hydrocarbon; CO – Carbon Monoxide; and PM – Particulate Matter.
2. Smoke shall not exceed above value throughout the operating load points of the test cycle.
3. The testing shall be done as per D2 – 5 mode cycle of ISO: 8178- Part 4.
4. The above mentioned emission limits shall be applicable for Type Approval and Conformity of Production (COP) carried out by authorized agencies.
5. Every manufacturer, importer or, assembler (hereinafter referred to as manufacturer) of the diesel engine (hereinafter referred to as ‘engine’) for genset application manufactured or imported into India or, diesel genset (hereinafter referred to as ‘product’), assembled or imported into India shall obtain Type Approval and comply with COP of their product(s) for the emission limits which shall be valid for the next COP year or, the date of implementation of the revised norms specified above, whichever earlier. Explanation.- The term ‘COP year’ means the period from 1st April to 31st March.
6. Stack height (in metres), for genset shall be governed as per Central Pollution Control Board (CPCB) guidelines.

1.3.16 GENERAL CONDITIONS

1.3.11.1 Applicability

These conditions shall apply to all new engines for genset application and products manufactured, assembled or, imported into India, as the case may be:
Provided that these rules, shall not apply to:

a. Any engine or product, assembled or manufactured or imported, as the case may be, for the purpose of export outside India, or;

b. Any engine or product intended for the purpose of sample limited to four in number and to be exported back within three months, and not for sale in India.

1.3.11.2 Requirement of certification

Every manufacturer of engine or product, as the case may be, shall have valid certificate(s) of Type Approval and COP for each COP year, for all engine models being manufactured or, for all engine or product models being imported, after the effective date for the emission limits, as specified above and the COP for the genset sold on or after 1st April, 2014 shall be effective and in force as per revised emission norms with effect from 1st April, 2010.

1.3.11.3 Sale, import or use of engine or product not complying with these rules

No person shall sell, import or use an engine for genset application or, a product which is not having a valid Type Approval certificate and certificate of COP referred to in condition 2.

1.17 Requirement of conformance labeling

a. All the engines, individually or as part of the product shall be clearly engraved ‘Genset Engine’ on the cylinder block.

b. The engine or the product shall be affixed with a conformance label meeting the following requirements, namely:-

i. the label shall be durable and legible;

ii. the label shall be affixed on a part necessary for normal operation of the engine or the product and not normally requiring replacement during the life of the engine or the product.

c. The conformance label shall contain the following information, namely:-

i. name and address of the manufacturer of engine or product, as the case may be;

ii. statement that the engine or product conforms to the Environment (Protection) Rules, 1986;

iii. Type Approval certificate number;

iv. date of manufacture of engine and the product or in case of import, the date of import of the engine and the product; and

v. rated speed and corresponding gross power in kW.

1.18 NODAL AGENCY

a. The Central Pollution Control Board shall be the nodal agency for implementation of these rules.
b. In case of any dispute or difficulty in implementation of these rules, the matter shall be referred to the nodal agency.

c. The nodal agency shall constitute a Committee to advise it on all matters, including the disputed matters, related to the implementation of these rules.

1.19. AUTHORISED AGENCIES FOR CERTIFICATION

The following institutions are authorised to carry out such tests as they may deem necessary, for giving certificates of Type Approval and Conformity of Production tests for diesel engines or products and to give such certificates, namely:

a. The Automotive Research Association of India, Pune (Maharashtra);

b. The International Centre for Automotive Technology, Manesar (Haryana);

c. The Indian Oil Corporation, Research and Development Centre, Faridabad (Haryana);

d. The Indian Institute of Petroleum, Dehradun (Uttarakhand); and

the Vehicle Research Development Establishment, Ahmednagar (Maharashtra).

1.20 COMPLIANCE AND TESTING PROCEDURE

a. The Compliance and Testing Procedure, as published by the Central Pollution Control Board shall be followed by all concerned.

b. The authorized agencies for certification shall submit the testing and certification details in respect of the emission to the Central Pollution Control Board annually.

1.21 FUEL SPECIFICATION

The specification of commercial fuel applicable for diesel genset shall be the same as applicable for commercial High Speed Diesel applicable for diesel vehicles in the area where product would be operated, from time to time, as per policy of Government of India.

1.22 ENGINE COMPONENT OR PARTS IDENTIFICATION

All the details of engine components or parts responsible for the emission performance shall be clearly marked in English language.

2. FUEL OIL PIPING

2.1 SCOPE

The scope of this section comprises the supply and laying of pipes, fittings and valves testing and balancing piping required for the complete installation as shown on the drawings. All piping inclusive of fittings and valves shall follow the applicable BIS Codes.

a. Pipes shall be MS seamless & fittings shall be welded type fittings conforming to relevant BIS codes. All jointing in the pipe system shall generally be by welding / flanges, unless otherwise mentioned or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS code of procedure for manual metalarc welding of mild steel.
b. All pipes and their steel supports shall be thoroughly cleaned and given a primary coat of red oxide paint before being installed. All welded piping shall be subject to the approval at site.

c. Thread joint fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type.

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

e. Valves, conforming to the following specifications, shall be provided as shown on drawings.

<table>
<thead>
<tr>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to 65 mm</td>
<td>Gun Metal</td>
<td>Flanged</td>
</tr>
<tr>
<td>75 mm over</td>
<td>Body cast iron spindle and valve seat of bronze or gun metal</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

All valves shall be heavy duty.

f. Flanges shall be approved make. The supply of flanges shall also include supply of bolts and nuts and suitable asbestos fibre / rubber insertion gaskets (minimum 3 mm thick).

g. Non-return (check) valves shall be provided as shown on the drawings, conforming to relevant BIS codes and in accordance with the following specifications:

<table>
<thead>
<tr>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to 65 mm</td>
<td>Gun Metal</td>
<td>Flanged</td>
</tr>
<tr>
<td>75 mm over</td>
<td>Cast Iron / Gun Metal</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

Swing check valves shall normally be used in all services. Lifts type valves may be used in horizontal runs.

h. The strainers shall be of cast iron body with gunmetal or bronze mesh for fine filtration of the oil.

i. All piping and fitting shall be pressure tested, then painted and shall be provided with additional weather proof treatment for buried pipes.

j. All piping shall be painted as specified herein. After piping has been installed, tested and run for at least three days of eight hours each, all exposed piping and pipe supports shall be given two finish coats, 3 mils each, of approved paint, conforming to relevant BIS codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows.

k. Operational Description

Supply of diesel to Day oil tank from the bulk oil storage tank shall be automatically controlled by providing level sensor on each tank and controlled by Solenoid valves. Single pipe line shall feed to number of tanks.
System shall be provided to return the diesel fuel automatically back to the bulk storage tank in the case of pump supplying diesel from the bulk storage tank to the Day oil tank over runs. Pump capacity and Head shall be worked out by the vendor on the basis of Site condition.
3. TESTING

3.1 GENERAL

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Owner’s site representative.

- Wiring continuity test.
- Insulation resistance test.
- Earth continuity test.
- Earth resistivity test.
- Test as per Appendix ‘E’ of IS:732 -1989

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidental necessary to conduct the above tests shall be provided by the Contractor at his own cost.

3.2 TESTING OF WIRING

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

3.3 INSULATION RESISTANCE TEST

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation shall have an insulation resistance greater than one megohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one a megohms. All equipments, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix ‘E’ of IS:732-1989 shall be done and all record to be maintained.

3.4 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.
3.5 TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCH

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Owner’s site representative as well as the local authorities.

APPENDIX - IV

LIST OF INDIAN STANDARDS (IS)

Latest edition of following standards shall be referred

IS : 374 Ceiling fans and regulators (3rd revision)

IS : 694 PVC insulated Electric cable for working voltage upto and including 1100 volts.

IS : 732 Code of practice for electrical wiring and installation

IS : 1255 Code of Practice for installation and maintenance of Power Cables upto and including 33 kV rating (Second Revision)

IS : 1258 Bayonet lamp holders (Third revision)

IS : 1293 Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.

IS : 1554 (Part - I) PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.


IS : 1885 Glossary of items for electrical cables and conductors

IS : 1913 General and safety requirements for fluorescent lamps luminaries
Tubular.

IS : 2026 - Part I to IV  Power Transformers/ Dry Type Transformers

IS : 2071                  Methods of high voltage testing
IS : 2309                  Protection of building and allied structures against lightning
IS : 2551-                Danger notice plate.
IS : 3427                  AC Metal enclosed switch gear and control gear for rated voltages above 1 KV and upto and including 52 KV.
IS : 3480                  Flexible steel conduits for electrical wiring.
IS : 3837                  Accessories for rigid steel conduit for electrical wiring.
IS : 4146                  Application guide for voltage transformers
IS : 4615                  Switch socket outlets.

IS : 5133  (Part -I)  Boxes for the enclosure of electrical accessories.

IS : 5216  (Part-I)  Guide for safety procedures and practices in electrical work.

IS : 5424                  Rubber mats for electrical purposes.

IS : 5578 & 11353         Marking and arrangement of bus bars
IS : 7098 - (Part - II)  Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS : 8130                  Conductors for insulated electric cables and flexible cords
IS : 8623 -(Part -I)  Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS : 8623 - (Part -II)  Bus Bar trunking system
IS : 8828  Miniature Circuit Breakers

IS : 9537  Rigid Steel Conduits for electrical wiring (Second Revisions)

IS : 10810  Methods of test for cables.

IS : 12640  Earth Leakage Circuit Breakers

IS : 13947 (Part-II)  Air Circuit Breakers

IS : 13947-(Part- )  Moulded Case Circuit Breakers

IS : 13947 - (Part- )  Degree of protection provided by enclosures for LV switchgear and control gear.

IS : 13947 (Part- )  General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.

IS : 15652  Insulating mats for electrical purposes.

I : 1651 & 1652  Stationary cells and batteries lead acid type.

A P P E N D I X - V

ABBREVIATIONS

The following abbreviations have been used in the accompanying Specifications, drawings and Schedule of Quantities.

CU  Stands for copper.

GI  Stands for Galvanised Iron (Mild Steel)

V  Stands for Volts

KV  Stands for Kilo Volts

HV  Stands for High Voltage (3.3 KV and above)

MV  Stands for Medium Voltage (110 V, 230 V, 415 V, 600 V, 110 V)

LV  Stands for Low Voltage (32 V & Below)

HT  Stands for High Tension
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT</td>
<td>Stands for Low Tension</td>
</tr>
<tr>
<td>SF6</td>
<td>Stands for SulphurHexa Fluoride Gas</td>
</tr>
<tr>
<td>VCB</td>
<td>Stands for Vacuum Circuit Breaker</td>
</tr>
<tr>
<td>PVC</td>
<td>Stands for Polyvinyl Chloride</td>
</tr>
<tr>
<td>AMP</td>
<td>Stands for Amperes</td>
</tr>
<tr>
<td>KWH</td>
<td>Stands for Kilowatt Hours</td>
</tr>
<tr>
<td>KW</td>
<td>Stands for Kilo Watts</td>
</tr>
<tr>
<td>BIS</td>
<td>Stands for Bureau of Indian Standards</td>
</tr>
<tr>
<td>IS</td>
<td>Stands for Indian Standards</td>
</tr>
<tr>
<td>IEC</td>
<td>Stands for International Electro technical Commision</td>
</tr>
<tr>
<td>IEE</td>
<td>Stands for Institution of Electrical Engineers - London</td>
</tr>
<tr>
<td>IEEE</td>
<td>Stands for Institution of Electrical &amp; Electronics Engineers</td>
</tr>
<tr>
<td>NEC</td>
<td>Stands for National Electrical Code</td>
</tr>
<tr>
<td>ACB</td>
<td>Stands for Air Circuit Breaker</td>
</tr>
<tr>
<td>RCCB</td>
<td>Stands for Residual Current Circuit Breaker</td>
</tr>
<tr>
<td>MCB</td>
<td>Stands for Miniature Circuit Breaker</td>
</tr>
<tr>
<td>MCCB</td>
<td>Stands for Moulded Case Circuit Breaker</td>
</tr>
<tr>
<td>SP</td>
<td>Stands for Single Pole</td>
</tr>
<tr>
<td>DP</td>
<td>Stands for Double Pole</td>
</tr>
<tr>
<td>TP</td>
<td>Stands for Triple Pole</td>
</tr>
<tr>
<td>TPN</td>
<td>Stands for Triple Pole and Neutral</td>
</tr>
<tr>
<td>4 Pole</td>
<td>Stands for 3 phase and neutral of same capacity (size)</td>
</tr>
<tr>
<td>MDB</td>
<td>Stands for Main Distribution Board</td>
</tr>
<tr>
<td>SDB</td>
<td>Stands for Sub Distribution Board</td>
</tr>
<tr>
<td>FDB</td>
<td>Stands for Final Distribution Board</td>
</tr>
<tr>
<td>MCC</td>
<td>Stands for Motor Control Centre</td>
</tr>
</tbody>
</table>
SPECIAL CONDITIONS

1. GENERAL
These special conditions are intended to amplify the General Conditions of Contract, and shall be read in conjunction with the same. For any discrepancies between the General Conditions, Special Conditions, specifications, tender drawings, CPWD General specification for HVAC 2016 and schedule of quantities, the following sequence shall be adhered to:

a. BOQ
b. Specifications, terms to conditions of this NIT
c. CPWD general specifications for HVAC works

Entire work shall be carried out as per provisions laid down in GRIHA, version 1.0 and ASHRAE standard 90.1–2007. The tenderer must refer to above documents at the time of bidding and no extra payment shall be due against non-inclusion of provisions listed in these standards.

2. SCOPE OF WORK
The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the department’s representative. The contractor shall furnish all labour, materials and equipment (except those to be supplied by the department if any) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete air conditioning system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The central Ventilation and Air-Conditioning (HVAC) system shall comprise of following:

a. Water Cooled Chilling Machines

b. Pumping system (Chilled & Condenser water)

c. Variable Frequency Drives

b. Motor control centers.
e. Chilled water, condensing water and drain water piping inclusive of all valves and fittings.

f. Insulation of pipes, pumps and tanks.

g. Vibration isolators for all HVAC equipment.

h. Dirt Separator

i. Wiring and earthing from MCC panels to various refrigeration, air conditioning and mechanical ventilation equipment, control wiring and interlocking.
j. Balancing, testing and commissioning of the entire HVAC and mechanical ventilation installation.

k. Test reports, list of recommended spares, as-installed drawings, operation and maintenance manual for the entire HVAC installation.

l. Complete co-operation with independent commissioning agent and corrective actions on snag list points prepared by such independent commissioning agent.

m. Training of department’s Staff.

2.1 Documentation as per GRIHA submission and List of Pre-functional checks.

In addition to the above, the Contractor’s work shall include, but not be limited to the following items, clarifications and/or modifications.

2.2 It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation. Any apparatus, appliance, material or work not shown on Drawings but mentioned in the Specifications, or vice versa, and any incidental accessories or minor details necessary to make the work complete and perfect in all respects and ready for operation, even if not specified, shall be provided without additional expense to the department.

2.3 Where variances occur between the Drawings and Specifications, or within either document itself, the item or arrangement of better quality, greater quantity, or higher cost shall be included in the Contract Price. The department will decide on the item and manner in which the work shall be installed.

2.4 If directed by the department, the Contractor shall, without extra cost, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

2.5 Included is the formal submission of testing reports, in a format acceptable to the department, for all inspection work.

2.6 The Contractor understands that testing work may not be continuous and may require the testing firm to return to the jobsite several times to perform testing as welds are completed and may require the submission of partial reports as work is completed. All costs associated with the performance of this work in such a manner are included. This Contractor will cooperate fully with and perform all work requested of said testing agency, inclusive of proving scaffolding or man-lift equipment to access the locations where tests are to be performed. Any welds not meeting the requirements of the specified standards shall be repaired and re-inspected at the sole cost of this Contractor without limitation.

2.7 Chilled and Condenser Water System: During flushing and cleaning operation no flow will be permitted through coils, heat exchangers, or chillers. This contractor shall install any required temporary by-pass piping to allow for circulation bypassing equipment coils during flushing and cleaning. Include sufficient sized bypasses as required to properly complete the operation. Provide a temporary skid-mounted pump with strainers or filters as required and temporary piping to accomplish filling and flushing of chilled and condenser water systems. This
contractor shall include if required all to operate pumping systems, during the cleaning and bleed/feed operations. The water treatment supplier shall certify in writing as to the adequacy of the cleaning and flushing performed under his supervision. Treatment reports, prepared by the water treatment supplier, for each system shall be formally submitted within one (1) week from the completion of the treatment process. Sufficient amounts of water treatment chemicals shall be immediately added after the system has been filled with clean water and will be supervised and maintained by this contractor until accepted by the department.

2.8 **Filter Requirements**

The Contractor shall furnish and install all work as it relates to filters serving HVAC equipment in accordance with the following:

[Reference: the following chart to be used in connection with the below procedures and requirements and kindly refer ASHRAE 55.2-2007 for further understanding on Filters type like A,B,C & D]

a. All HVAC Equipment shall be initially started up and operated with one (1) complete set of construction “pre” filters.

b. Upon completion of equipment startup the initial set of construction “pre” filters shall be removed and replaced with a complete set of “pre” filters attached with clips to a complete set of “post” filters. This arrangement shall be used to perform the final equipment testing, adjusting, and air balancing, commissioning and turnover to Ownership.

c. At the close of the project a complete set of “final” filters shall be delivered to the jobsite for turn over to department.

d. All HVAC Equipment shall be delivered to the jobsite without any filters installed (all filters shall be shipped lose in separate deliveries from the equipment they serve).

e. All sets of filters shall be furnished by the Contractor furnishing the associated equipment.

f. The Contractor shall provide all labour associated with the receipt, handling, distribution and installation of all filters.

g. Contractor is responsible to inventory and store pre-purchased air filters. Contractor is responsible to deliver and install filters as directed by department.

2.9 All equipment and materials shall be provided in strict accordance with the approved submissions bearing the approval stamps of the department. Any equipment provided that deviates in any way from the approved submissions (i.e. equipment motor manufacturer, isolators, etc.) shall be removed from the jobsite within 24-hours’ notice from the department and replaced with the approved item(s). All costs related to such replacements, both direct and indirect, shall be the responsibility of the Contractor.

3 ASSOCIATED CIVIL WORKS

3.1 Following civil works associated with HVAC installation are included in the scope of this contract. These shall be executed by other agencies in accordance with approved shop drawings of and under direct supervision of the air conditioning contractor.

a. RCC foundation for water chilling machines, pumps & centrifugal fans with angle iron frame work at the edges to protect these from damage.

b. RCC basin & supports & MS Joists for cooling towers.
c. PCC foundation blocks with angle iron frame work edging for all motor control centre.

d. PCC foundation for pot strainers and expansion tank.
e. Supply and fixing of G.I./wooden frame for mounting of grilles in masonry walls.
f. PCC foundation blocks for all air handling units and Heat Recovery Unit.

3.2 Following civil works associated with HVAC installation are excluded from the scope of this contract. These shall be executed by other agencies in accordance with approved shop drawings of and under direct supervision of the air conditioning contractor.

a. Thermal insulation of terraces above air-conditioned areas exposed to sun.
b. Air-tight fire doors with minimum two hour fire rating for plant rooms and other equipment rooms.
c. Masonry drain channels and sumps with CI gratings in AC plant room including provision for sump pump (if required) and disposal.

4. ASSOCIATED SERVICES WORKS

a. All associated ELECTRICAL WORKS listed below are excluded from the scope of this contract. These shall be installed by other agencies in accordance with approved shop drawings of, and under direct supervision of the air conditioning contractor.

i. Providing power supply with earthing at the incoming of control panel in A/C plant room.

ii. Providing power supply and earthing at the incoming MCCB in each air handling unit control panel.

iii. Providing power and earthing at the incoming MCCB in each centrifugal fan panel and pump panel at locations called for on air conditioning Contractor’s shop drawings.

iv. Providing 15 amps power outlet within 2 meter reach of each fan coil unit and VAV boxes at locations called for on air conditioning Contractor’s shop drawings.

v. Providing 15 amps power outlet within 2 meter reach of each single phase propeller fan at locations called for on air conditioning contractor’s shop drawings.

vi. Providing wiring and earthing for sump pumps in air conditioning plant room.

Note: The HVAC contractor shall closely coordinate with electrical contractor for obtaining these provisions. HVAC contractor shall conform in writing indicating desired electrical load and incoming cable size to the electrical contractor for his equipment.
b. All associated **PLUMBING WORKS** listed below are excluded from the scope of this contract. These shall be installed by other agencies, in accordance with approved shop drawings of, and under direct supervision, of the air conditioning contractor.

i. Providing soft makeup water (Commercial hardness 0 ppm and PH 7±1) at cooling tower, air washers, humidifiers at PAC units and at chilled/hot water expansion tank.

ii. Providing sump pumps and necessary piping for drainage of air conditioning plant room and other machine rooms located below ground level.

iii. Providing floor drains in cooling tower area and in air handling unit rooms.

iv. Disposal of condensate drain from fan coil units beyond the condensate drain riser.

4. **BUILDING AUTOMATION SYSTEM**

The scope of HVAC Contractor shall include the following for the interface to Building Automation System.

a. Stop/Manual/ Auto switches along with potential free contacts for monitoring the manual operation status, to be provided for those equipment whose start / stop is controlled by Building Automation System.

b. Potential free ‘NO’ contacts for monitoring ‘Run’ status of equipment wherever required.

c. Necessary contactor with potential free contacts and Stop/Manual/ Auto switches to be provided for all 1-phase equipment such as Propeller fans etc. wherever the starter is not provided and which requires starting / stopping through Building Automation System.

d. Sockets/Nipples with shut-off valve for mounting sensors/transmitters on pipe lines.

e. Installation of all motorized control valves with provision of counter flanges, nut-bolts and gaskets shall be provided by the HVAC contractor. Interface cards (0-10 V or 4-20 mA) if required shall be the scope of HVAC contractor for operation of valves & all the valve shall be calibrated by HVAC contractor (if it is supplied by them) before connecting it to BAS.

f. The space provision in all the equipment panel (MCC) such as Fans, Pumps, etc. for mounting Current/ Potential transformers & transducers and power supply to the transducer shall be provided by the HVAC contractor. Separate current transformers shall be provided by HVAC contractor for monitoring current / KWH (wherever required) through BAS.

g. The installation of current transformer & Transducer along with wiring between Current Transformer & Transducer up to the terminal block shall be provided by the HVAC contractor. All transducers shall be supplied by BAS contractor.
h. The low voltage BAS Cables shall be brought upto the electric panel by BAS contractor and all terminations into the electrical panels shall be made by HVAC contractor after satisfying himself of the wiring system. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the HVAC system, lies solely with the contractor.

i. Provision for mounting level switch on cooling tower sump & expansion tank shall be provided by HVAC contractor. Level switches shall be supplied by BAS contractor.

j. 32 Amps MCB on HVAC plant room panel for power supply to DDC. Panel.

k. 15 Amps. Power supply with MCB shall be provided on all HVAC panels and 32 Amps MCB on HVAC plant room panel for power supply to DDC. Panel.

l. All necessary Hardware/ Software shall be made available by the HVAC Contractor on the chiller Microprocessor panel for the integration of chiller panel to Building Automation System for remote monitoring / controlling of all parameters of chiller thru BAS.

6. IMPORTED EQUIPMENT

The successful tenderer shall submit upon award the following to facilitate the department in their application for concessional duty for equipment/material proposed to be directly purchased and imported by them.

a. Four copies of proforma invoice from Manufacturer/Supplier drawn in the name of department identifying FOB price from the country of origin and Freight cum Insurance upto site.

b. Four sets of Technical .Literature, high lighting model number and all technical details of the actual equipment/material offered by them.

c. Successful bidder shall indicate packing specification for imported equipment / material.

d. Successful bidder shall furnish undertaking from local agents for all imported equipment that they will provide all technical data & engineering information on the product through their principles, all back-up services during detailed engineering testing and commissioning and service during and after the defects liability period.

e. Computerized equipment selection print outs.

7. BYE-LAWS AND REGULATIONS

The installation shall be in conformity with the Bye-laws, Regulations and Standards of the local authorities concerned, in so far as these become applicable to the installation. But if these Specifications and Drawings call for a higher standard of materials and / or workmanship than those required by any of the above regulations and standards, then these Specifications and Drawings shall take precedence over the said regulations and standards. However, if the Drawings and specifications require something which violates the Bye-laws and Regulations, then the Bye-laws and Regulations shall govern the requirement of this installation.
8. FEES AND PERMITS
The Contractor shall obtain all permits/licenses. The fees (if any) shall be paid by the department on submission of the document for inspection, approval, and commissioning of their installation.

9. DRAWINGS
The HVAC Drawings listed under Appendix-I, which may be issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of equipment, controls, grilles, and diffusers.

The contractor shall follow the tender drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.

HVAC contractor shall prepare co-ordinated services drawings to satisfy false ceiling heights and reflected ceiling plans as required by the status of work. Soft copies of other services shall be forwarded to HVAC contractor for co-ordination. In case of routing conflict, HVAC contractor shall indicate suitable modification in routing for other services. HVAC contractor shall clearly indicate false ceiling trap door requirement for suspended HVAC equipment in time otherwise any rework in false ceiling to provide trap door shall be at HVAC contractor’s cost.

Maximum headroom and space conditions shall be maintained at all points. Where headroom appears inadequate, the contractor shall notify to the department before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and contractor shall rectify the same at his own cost.

The contractor shall examine all architectural, structural, plumbing, electrical, and other services drawings and check the as-built works before starting the work, report to the department any discrepancies and obtain clarification.

Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the department without additional cost to the department. The data given in the Drawings and Specifications is as exact as could be procured, but its accuracy is not guaranteed.

10. TECHNICAL DATA
Each tenderer shall submit along with his tender, the technical data for all items listed in Appendix-IV in the indicated format. Failure to furnish complete technical data with tenders may result in summary rejection of the tender.

11. SHOP DRAWINGS
11.1 All the shop drawings shall be prepared on computer through Autocad System based on Architectural Drawings, site measurements, and Interior Designer’s Drawings. All heat load calculations shall be done using the latest version of E-20 or Trace 600 only. Within three weeks of stipulated date of start, contractor shall furnish, for the approval of the department, two sets of detailed shop drawings of all equipment and materials including layouts for Plant room, cooling towers, fan coil units, ventilation fans; detailed ducting drawings showing exact location of
supports, flanges, bends, tee connections, reducers, guide vanes, silencers, distribution grids, volume control dampers, collars, grilles, diffusers; detailed piping drawings showing exact location and type of supports, valves, fittings etc; acoustic lining and external insulation details for ducts, pipe insulation etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations. These shop drawings shall contain all information required to complete the Project as per specifications and as required by the department. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 12 sets of drawings shall be submitted after final approval along with CD.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III and quoted by the tenderer in technical data part of Appendix - IV. When the department makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints, for approval. The contractor shall submit further twelve sets of shop drawings to the department for the exclusive use by the department and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material/equipment/installation.

11.2 Shop drawings shall be submitted for approval three weeks in advance of planned delivery and installation of any material to allow department ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

11.3 Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

11.4 Samples of all materials like grilles, diffusers, controls, insulation, premoulded pipe section, control wires etc. shall be submitted to the department prior to procurement. These will be submitted in two sets for approval and retention by department and shall be kept in their site office for reference and verification till the completion of the Project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installation.

11.5 Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.
11.6 Where the contractor proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts; all such redesign, and all new drawings and detailing required therefore, shall be prepared by the contractor at his own expense and gotten approved by the department. Any delay on such account shall be at the cost of and consequence of the Contractor.

11.7 HVAC Contractor shall prepare coordinated services shop drawings based on the drawings prepared by Electrical, Plumbing & Low Voltage Contractors to ensure adequate clearances are available for installation of services for each trade.

Where the work of the contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the department, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the department.

11.8 Within four weeks of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this contract. The Project Manager shall make recommendation to department for acceptance of anticipated variation in contract amounts and also advise department to initiate action for procurement of spare parts and tools at the completion of project.

12. QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the department. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense. The contractor shall guarantee that the equipment installed shall maintain the specified dB / NC levels.

13. ACCESSIBILITY

The Contractor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings for proper installation of his ducting and piping. His failure to communicate insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same. The Contractor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed control damper, valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work.
Failing this, the Contractor shall make all the necessary repairs and changes at his own expense. Access panel shall be standardised for each piece of equipment / device / accessory and shall be clearly nomenclatured / marked.

14. MATERIALS AND EQUIPMENT
All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per Appendix - III.

15. MANUFACTURERS INSTRUCTIONS
Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, such instructions shall be followed in all cases.

16. ELECTRICAL INSTALLATION
The electrical work related to air conditioning services, shall be carried out in full knowledge of, and with the complete coordination of the contractor. The electrical installation shall be in total conformity with the control wiring drawings prepared by the contractor and approved by the department. All air conditioning equipment shall be connected and tested in the presence of an authorised representative of the contractor.

The air conditioning system shall be commissioned only after the contractor has certified in writing that the electrical installation work for air conditioning services has been thoroughly checked, tested and found to be totally satisfactory and in full conformity with the contract Drawings, Specifications and manufacturers instructions. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the electrical installation work for air conditioning services, lies solely with the contractor.

17. COMPLETION CERTIFICATE
On completion of the Electrical installation for air conditioning, a certificate shall be furnished by the contractor, counter signed by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority.

The contractor shall be responsible for getting the entire electrical installation for air conditioning system duly approved by the local authorities concerned, and shall bear expenses if any, in connection with the same.

18. BALANCING, TESTING AND COMMISSIONING
Balancing of all air and water systems and all tests as called for the Specifications shall be carried out by the contractor through a specialist group, in accordance with the Specifications and ASHRAE Guide lines and Standards. Performance test shall consist of three days of 10 hour each operation of system for each season.
The results for summer, monsoon and winter air conditioning in quadruplicate, shall be submitted for scrutiny. Four copies of the certified manufacturers performance curves for each piece of equipment, high lighting operational parameters for the project, shall be submitted alongwith the test certificates. Contractor shall also provide four copies of record of all safety and automatic control settings for the entire installation.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the department. All tests shall be carried out in the presence of the representatives of the department.

19. COMPLETION DRAWINGS
Contractor shall periodically submit completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of CD’s and four portfolios (A-1 or A-0 size) each containing complete set of drawings on approved scale indicating the work as installed. These drawings shall clearly indicate complete plant room layouts, ducting and piping layouts, location of wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, dampers, wiring and other services.

Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The contractor shall frame under glass in the airconditioning plant room, one set of these consolidated control diagrams. Diagrams shall include GA & SLD of HVAC MCC, schematic piping drawing and HVAC plant room layout

20. OPERATING INSTRUCTION & MAINTENANCE MANUAL
Upon completion and commissioning of part HVAC system the contractor shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer’s operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals; one each for retention by department and two for department’s Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4 year period of maintenance of each equipment.

21. ON SITE TRAINING
Upon completion of all work and all tests, the Contractor shall furnish necessary operators, labour and helpers for operating the entire installation for a period of fifteen (15) working days of ten (10) hours each, to enable the department’s staff to get acquainted with the operation of the system. During this period, the contractor shall train the department’s personnel in the operation, adjustment and maintenance of all equipment installed

22. MAINTENANCE DURING DEFECTS LIABILITY PERIOD
22.1 Complaint
The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

22.2 Repairs

All equipment that require repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs concurrently with the defects liability period, all replacement parts and labour shall be supplied promptly free-of-charge to the department.

23. UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all temperatures, pressures, humidity, power consumption, starting and stopping times for various equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Contractor shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the department’s review. This shall include the type of service planned to be offered during Defects Liability Period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the Management.

The tenderer shall include a list of other projects where such an Operation Assistance has been provided.

24. OPERATION AND MAINTENANCE

Contractor may be required to carry out the operation of the HVAC installation for the defects liability period. Further, he may also be required to carry out operation and all inclusive maintenance of the entire system for a period of three years beyond the defects liability period.

24.1 Operation contract (HVAC System)

i. 12 hours a day, Year round.

ii. All stand-by equipment to be operated as per mutually agreed programme.

iii. Proper entry and upkeep of relevant log books.


v. Proper housekeeping of all areas under the contract.

vi. Prepare daily consumption report and summary of operation.

24.2 Terms of payment
i. Quarterly at the end of each quarter on pro-rata basis.

24.3 All Inclusive Maintenance Contract

a. Routine Preventive Maintenance Schedule to be submitted
   i. Schedule to cover manufacturer’s recommendation and/or common engineering practice (for all plant and machinery under contract).
   ii. Plant and machinery history card giving full details of equipment and frequency of checks and overhaul.
   iii. Monthly status report.
   iv. Entire HVAC installation to be painted in fourth year (from commissioning) before the expiry of operation and maintenance contract.

b. Uptime during maintenance contract
   i. 98% uptime of all systems under contract.
   ii. Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.
   iii. There shall be no reimbursement for the extended period.
   iv. Break-downs shall be attended to within ten hours of reporting.
   v. Spare compressor/motor assembly to be made available within seven calendar days in case of total breakdown/burnout.

c. Manpower
   i. Adequate number of persons to the satisfaction of the department site representative shall be provided including relievers.
   ii. Statutory requirements of EPF, ESIC and other applicable labour legislations to be complied with; and monthly certification to that effect to be submitted.
   iii. Duty allocation and Roaster control shall be contractor’s responsibility.
   iv. No overtime shall be payable by department for any reason whatsoever.

d. Shut Downs
   i. Routine shut downs shall be permitted only during winter season for chillers.
   ii. Contractor shall be at liberty to carry out routine maintenance as and when required but with prior permission of the department.

e. Payment Terms
i. Quarterly payment at the end of each quarter on pro-rata basis.

25. PARTIAL ORDERING
Department reserves the right to order equipment and material from any and all alternates, and/or to order high side and/or low side equipment and materials or parts thereof from one or more tenderers.

26. SOFT WATER AND POWER REQUIREMENT
The contractor shall submit with their tender, their requirement of soft make-up water and power requirement. Power at each of their equipment/system wise/floor wise/section wise.

APPENDIX – I
List of Drawings
APPENDIX – II

4.1 GUARANTEE PROFORMA

GUARANTEE FOR AIR CONDITIONING & VENTILATION INSTALLATION

We hereby guarantee the year round Ventilation and Air Conditioning System which we have installed in the Complex described below:

Building: TEACHING HOSPITA

Location: BARIPAD, ODISHA

For a period of 12 months from the date of acceptance of the total installation, we agree to repair or replace to the satisfaction of the department, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorise the CPWD to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.
We also hereby undertake to test the entire installation in first summer, monsoon and winter on following the completion of the installation, to check and do everything necessary to ensure that the specified indoor conditions in all spaces are maintained, that all water and air systems are properly balanced, that all controls are calibrated accurately, and that all units are functioning satisfactorily.

SIGNATURE OF CONTRACTOR
for HVAC INSTALLATION

DATE : 
SEAL

5

APPENDIX – III

5.1 SCHEDULE OF TECHNICAL DATA

Contractor shall follow the technical specifications as per tender.

5.1.1.1
1. WATER CHILLING MACHINE

5.1.1.2 1.1 COMPRESSOR.

  a. Manufacturer (Make)
  b. Country of Origin
  c. Model & type
  d. No of compressors per chiller
  e. Type of Compressor
  f. Refrigerant
  g. Saturated suction temp (°C)
  h. Saturated condensing temperature (°C)
i. Discharge gas temp (°C)

j. Cooling Capacity at above conditions (TR)

k. Compressor shell test pressure (Kg/cm²)

l. Method of oil cooling

m. Quantity of refrigerant for initial charge (KG)

n. Power consumption

<table>
<thead>
<tr>
<th>Load</th>
<th>kW/TR at tender design conditions &amp; with ARI relief</th>
<th>kW/TR at ARI 550/590 conditions</th>
<th>kW/TR at tender design conditions &amp; constant condenser water entering temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>75%</td>
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<td></td>
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<tr>
<td>50%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>25%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part load value</td>
<td>NPLV =</td>
<td>IPLV =</td>
<td>PLV =</td>
</tr>
</tbody>
</table>

o. Recommended Range of capacity variation (%)

p. HP/LP/OP cutout set pressures (Kg/cm²)

q. Type of bearings.

r. Lubrication arrangement (Attach sketch or write-up)

**Note:** In case the machine consists of multiple compressors, then power consumption of each compressor shall be indicated at part load in kW/TR. Type of capacity control shall also be indicated.

1.2 COMPRESSOR MOTOR:

a. Motor manufacturer

b. Type

c. KW Rating / Power factor

d. Electrical Characteristics (±10% voltage variation)

e. Motor RPM.
f. Insulation class.
g. Enclosure/protection class.
h. Efficiency.
i. Starter manufacturer & mode of start.
j. Starting current (Amps)
k. Full load current FLA (Amps)
l. Locked rotor current (Amps)
m. Type of vibration isolation for compressor and motor.

1.3 CONDENSER

5.1.1.3
5.1.1.4 WATERCOOLED CONDENSER

5.1.1.5 a. Manufacturer (Make) Model
5.1.1.6 b. Shell Material
5.1.1.7 c. Tube material / No. of tubes / Tube OD

5.1.1.10 d. Number of passes

5.1.1.11 e. Fouling factor (FPS)

5.1.1.12 f. Water Flow (USGPM)
5.1.1.13

5.1.1.14 g. Water velocity in tubes (m/s)
5.1.1.15 h. Water side Pressure drop (Kg/cm²)
5.1.1.16 i. Water temperature In/Out (°F/°C)
j. Design degree of sub-cooling (°F/°C)

5.1.1.17 k. Shell side design pressure (Kg/cm²)
5.1.1.18 l. Tube side design pressure (Kg/cm²)
5.1.1.19 m. Shell side test pressure (Kg/cm²)
5.1.1.20 n. Tube side test pressure (Kg/cm²)
5.1.1.21 o. Pressure relief valve set pressure (Kg/cm²)
ACTUAL capacity of condenser at above conditions (Btu/hr)

1.4 COOLER

a. Manufacturer (Make) Model
b. Shell Material
c. Tube material / No. of tubes / Tube OD
d. Type (DX / Flooded)
e. Fouling factor (FPS)
f. Water Flow (USGPM)
g. Water velocity in tubes in case of flooded cooler (m/s)
h. Pressure drop (Kg/cm²)
i. Shell side design pressure (Kg/cm²)
j. Tube side design pressure (Kg/cm²)
k. Shell side test pressure (Kg/cm²)
l. Tube side test pressure (Kg/cm²)
m. Pressure relief valve set pressure (Kg/cm²)
n. Shell insulation at MFR works – Material & Thickness (mm)
o. Water temperature, IN/OUT (⁰F/⁰C)
p. ACTUAL capacity of cooler heat exchanger at above conditions (TR)

1.5 MICROPROCESSOR CONTROL CENTRE

a. Indicate point wise display system, set points etc.
b. Interface with BAS (Confirm provided)

1.6 GENERAL

a. Original computer printout of machine selection from manufacturer to be attached with the offer, confirm.
b. ARI / Eurovent certified (confirm)

c. Overall Dimension (M)

---
5.1.2.5
5.1.2.6  d. Operating weight (kg) / shipping wt.
5.1.2.7
5.1.2.8  e. Service clearance required (M) L x B x H.

5.1.2.9  f. Sound power level (dB) in each octave band.

<table>
<thead>
<tr>
<th>Mid freq.</th>
<th>63Hz</th>
<th>125Hz</th>
<th>250Hz</th>
<th>500Hz</th>
<th>1000Hz z</th>
<th>2000Hz z</th>
<th>4000Hz z</th>
<th>8000Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWL(DB)*</td>
<td></td>
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</table>

* SPL ref to $10^{-12}$ W

g. Sound pressure level at 3m horizontal distance (dBA)
h. Acoustic enclosure included (if required) to achieve 80 dBA at 1 meter distance.

- Furnish list of the projects where acoustic enclosure has been provided to achieve 80 dBA.
i. Type of vibration isolators and vibration isolation efficiency(%)
2.2 AUTOMATIC AFD BY PASS:
   a. Make / Country of Origin
   b. Model No.
   c. Type
   d. Motor Rating
   e. Rated Current
   f. Rating of Power disconnect switch.
   g. Type of Enclosure

2.3 PUMP LOGIC CONTROLLER
   a. Make / Country of Origin
   b. Model No.
   c. Microprocessor
   d. No. of Bits.
   e. Clock Frequency
   f. RAM Memory
   g. Power supply

2.4 DIFFERENTIAL TRANSMITTER/SENSOR
   b. Model No.
   c. Type
   d. Constructional Material
   e. Sensing Element Material for pressure & flow rate.
   f. Maximum Static pressure
   g. Power supply
   h. Degree of Protection

2.5 SECONDARY PUMP (CHILLED WATER)
   a. Manufacturer & Model
   b. Type
c. Capacity (USGPM)

For SCHWP indicate capacity at varying speed.

d. Head (ft.)

e. Efficiency (%)

f. Pump (RPM)

5.1.2.9.1
5.1.2.9.2

g. B.H.P

h. Motor (HP)

i. Motor make.

j. Electrical characteristics (±10% voltage variation)

k. Motor efficiency and class of insulation.

l. Full load current (Amps)

m. Starting current (Amps)

n. Locked rotor current on full load (Amps)

o. Impeller material

p. Type of water seals.

q. Vibration isolation

r. Operating weight (Kg)

s. Overall dimensions (M)(LxWxH)

**NOTE**: Performance curves for each pump shall be submitted along with the technical submittal.

3. PRIMARY CHILLED WATER PUMPS

a. Manufacturer & Model.

b. Type

c. Capacity (USGPM)

d. Head (ft.)

e. Efficiency (%)

f. Pump (RPM)
5.1.2.9.3
5.1.2.9.4  g. B.H.P

h. Motor (HP)

i. Motor make.

j. Electrical characteristics (±10% voltage variation).

k. Motor efficiency and class of insulation.

l. Full load current (Amps)

m. Starting current (Amps)

n. Locked rotor current on full load (Amps)

o. Impeller material

p. Type of water seals.

q. Vibration isolation

r. Operating weight (Kg)

s. Overall dimensions (M)(LxWxH)

5.1.2.10  Note: Performance curves for each pump shall be submitted along with the technical submittal.

5.1.2.11  4. CONDENSER WATER PUMPS

a. Manufacturer & Model.

b. Type

c. Capacity (USGPM)

d. Head (ft.)

e. Efficiency (%)

f. Pump (RPM)

5.1.2.11.1
5.1.2.11.2  g. B.H.P

h. Motor (HP)

i. Motor make.

j. Electrical characteristics (±10% voltage variation).

k. Motor efficiency and class of insulation.
l. Full load current (Amps)
m. Starting current (Amps)
n. Locked rotor current on full load (Amps)
o. Impeller material
p. Type of water seals.
q. Vibration isolation
r. Operating weight (Kg)
s. Overall dimensions (M)(LxWxH)

5.1.2.12 Note: Performance curves for each pump shall be submitted along with the technical submittal.

5.1.2.13 5. COOLING TOWER

a. Manufacturer
b. Type (Induced/Forced draft)
c. Model
d. Capacity TR
e. Water flow rate (US GPM)
f. Range Deg. F
g. Approach Deg F
h. Casing Material
i. Basin Material
j. Eliminators Material
k. Piping Material and size.
l. Mechanical equipment supports material
m. Fill Material
n. Ladder Material
o. Fan dia and RPM
p. Fan Motor
i. Make
ii. Type

5.1.2.13.1 iii. HP

5.1.2.13.2 iv. RPM
v. Efficiency and class of insulation.
vi. Electrical Characteristics (±10% voltage variation)
vii. Full load / current
viii. Type of starter & manufacturer

q. Noise level (DB) at following distance from cooling tower
   10 metre
   15 metre
   20 metre

r. Drift Loss % of water flow.
s. Evaporative Loss %
t. Total makeup water required (US Gallons/Hr)
u. Water equalizing connection for multiple cooling towers
v. Operating weight Kg.
w. Overall dimensions (M)(LxWxH)

6. **CLOSED EXPANSION TANK/AIR SEPARATOR**  
   **CHW**
   **HW**
   a. Make
   b. Type
   c. Capacity (Volume)
   d. Material of Construction
e. Working philosophy (Describe)
f. List of recommended accessories included.
g. Make of Air Separator
7. **HOTWATERGENERATOR**

a. Make  
b. Design Capacity  
c. Type  
d. Model  
e. Banks  
f. Vessel size  
g. Thickness  
h. Shell  
i. Dished ends  
j. Material  
k. Density  
l. Dimensions (LxWxH)  
m. Heaters  
n. Test Pressure  
o. Controls  
p. 8. **AIR HANDLING UNIT**

8.1 **GENERAL**

- a. Manufacturer  
- b. Type of unit (Double/Single skin) (draw-thru/blow thru)  
- 1. c. Material and thickness of casing (inner/outer)  
- 2. 3. d. Material and thickness of drain pan.  

e. Material and thickness of sandwiched insulation for drain pan  
f. Type of flexible connection  
g. Type of vibration isolator  

8.2 **FAN SECTION**
a. Manufacturer.
b. Type of fan and model number
c. Material and thickness of fan wheel blades
d. Material and thickness of housing.
e. Confirm statically and dynamically balanced to grade 6.3 (complete fan motor assembly)
f. Type of bearings.
g. Fan RPM

5.2

8.3 MOTORS

a. Manufacturer
b. Type
c. Electrical characteristics (±10% voltage variation)
d. Motor speed (RPM)
e. Motor Efficiency
f. Class of Insulation
g. Motor operated through VFD, confirm following:
   i. Motors do not get derated
   ii. Higher size motor is not required.

8.4 COOLING COIL

a. Manufacturer
b. Material of tubes
c. Material of fins
d. No of fins/inch
e. Test pressure.

8.5 AIR FILTERS

a. Manufacturer
b. Type of filters

c. Filter medium

d. Pressure drop across filters (mm. of water) / Clean & Dirty

e. Efficiency

8.6 AIR HANDLING UNITS (OPERATING DATA)

AHU NO.

AIR QTY (CFM)

TOTAL SP (mmWg)

FAN ABSORBED POWER (BHP/BkW)

FAN SPEED (RPM)
FAN OUTLET VELOCITY (FPM or m/s)

FAN MOTOR (HP/kW)
### SOUND POWER LEVEL (DB re 10^{-12}W)

<table>
<thead>
<tr>
<th>Mid Freq.</th>
<th>63Hz</th>
<th>125Hz</th>
<th>250Hz</th>
<th>500Hz</th>
<th>1000Hz</th>
<th>2000Hz</th>
<th>4000Hz</th>
<th>8000Hz</th>
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</thead>
<tbody>
<tr>
<td>SWL(dB)</td>
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<td></td>
</tr>
</tbody>
</table>

### SOUND PRESSURE LEVEL(dBA) at fan outlet

<table>
<thead>
<tr>
<th>Mid Freq.</th>
<th>63Hz</th>
<th>125Hz</th>
<th>250Hz</th>
<th>500Hz</th>
<th>1000Hz</th>
<th>2000Hz</th>
<th>4000Hz</th>
<th>8000Hz</th>
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<tbody>
<tr>
<td>SPL(dB)</td>
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<td></td>
</tr>
</tbody>
</table>

### COIL FACE AREA (Ft²)

|          |      |       |       |       |        |        |        |        |

### COIL FACE VEL (FPM)

|          |      |       |       |       |        |        |        |        |

### AIR SIDE PRESSURE DROP ACROSS COOLING COIL (mmWg)

|          |      |       |       |       |        |        |        |        |

### WATER SIDE PRESSURE DROP IN COOLING COIL (Kg/cm²)

<p>| | | | | | | | | |
|          |      |       |       |       |        |        |        |        |</p>
<table>
<thead>
<tr>
<th>NUMBER OF ROWS</th>
<th>WATER VELOCITY IN TUBES (m/s)</th>
<th>TYPE OF FILTERS</th>
<th>FILTER FACE VELOCITY (FPM or m/s)</th>
<th>FILTER EFFICIENCY (%) &amp; PARTICLE SIZE (µm)</th>
<th>AIR PRESSURE DROP IN CLEAN &amp; DIRTY CONDITIONS (mmWg)</th>
<th>OVERALL DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LxWxH (METRES)</td>
</tr>
</tbody>
</table>
OPERATING WEIGHT

9. **FAN COIL UNITS**

<table>
<thead>
<tr>
<th>Capacity (TR)</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
</tr>
</thead>
</table>

a. Manufacturer

b. Model Type

c. Actual Capacity (TR) at
   - HI Speed.
   - MED Speed
   - LO speed.

d. Actual Air Quantity (CFM) at
   - HI Speed.
   - MED Speed
   - LO speed.

e. Coil face area (ft²)

f. Unit size: L mm W mm H mm

g. Material/Gage
   i. Casing
   ii. Blowers
   iii. Drain pan with sandwich insulation.
   iv. Copper Tubes dia & wall thickness
   v. Fins/inch

h. Rows of cooling coil, air side & water side pressure drops

i. Type of filter

j. Motor make

k. Motor H P/RPM
l. Electrical characteristics. (230 ± 6% volts)

m. Material of flexible connection

m. Type of vibration isolators

<table>
<thead>
<tr>
<th>10. FANS</th>
<th>Centrifugal Fans</th>
<th>Axial Flow Fan</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2.1.1.1</td>
<td>GENERAL</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Bearings</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Casing Material</td>
<td></td>
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<tr>
<td>e.</td>
<td>Impeller Material</td>
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<tr>
<td>f.</td>
<td>Shaft Material</td>
<td></td>
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<tr>
<td>g.</td>
<td>Vibration Isolators</td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>Fan Size and Model</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Fan speed</td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td>Fan efficiency</td>
<td></td>
</tr>
<tr>
<td>k.</td>
<td>Noise level</td>
<td></td>
</tr>
<tr>
<td>l.</td>
<td>Noise attenuator</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Manufacturers</td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td>DB reduction guaranteed at 2 M &amp; 3 M distance from Noise attenuator</td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>length (Metre)</td>
<td></td>
</tr>
</tbody>
</table>

m. Motor

i. manufacturer

ii. type

iii. operating speed

iv. motor efficiency and class of insulation.

v. Electrical Characteristics (±10% voltage variation).

vi. Type of starter & manufacturer

n. Type of drive

o. Material of flexible connection

p. Type of vibration isolators

q. Motor operated through VFD, confirm following:
i. Motors do not get derated
ii. Higher size motor is not required.

### 10.2 OPERATING DATA

<table>
<thead>
<tr>
<th>Centrifugal</th>
<th>Axial Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAN MODEL</strong></td>
<td></td>
</tr>
<tr>
<td><strong>FAN CFM</strong></td>
<td></td>
</tr>
<tr>
<td><strong>FAN OUTLET VELOCITY (FPM)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>SP (MM)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>FAN RPM</strong></td>
<td></td>
</tr>
<tr>
<td><strong>NOISE LEVEL (DB)</strong></td>
<td></td>
</tr>
</tbody>
</table>
DB REDUCTION BY ATTENUATOR

RESULTANT NOISE LEVEL (DB)

BHP

LIMIT LOAD HP

MOTOR (HP)

FULL LOAD CURRENT (AMPS)

STARTING CURRENT (AMPS)
5.2.1.2 11. PROPELLER FANS

a. Manufacturer
b. Motor HP
c. Capacitors provided.
d. Speed Regulator for single phase fans
e. Gravity louvers
f. Single phase preventor for 3 phase fans
g. Back draft damper.
h. Bird Screen
i. Wire guard

5.2.1.3 12. CONTROLS

12.1 2 WAY VALVE

<table>
<thead>
<tr>
<th></th>
<th>AHU’s</th>
<th>FCU’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Make of valve</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Type (Modulating/Diverting)</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Modulating Motor make</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Spring return function</td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td>Pressure rating</td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>Voltage of motor</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Transformer provided</td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td>Valve linkage make and model.</td>
<td></td>
</tr>
</tbody>
</table>

5.2.1.3.1 12.2 THERMOSTAT FOR FAN COIL UNIT

a. Make / Type
b. Model

c. Cooling/heating or cooling only

d. Range

e. Differential

f. Fan Speeds

g. Sub base provided

h. Electrical characteristics

13. ADDITIONAL CONTROLS MAKE AND MODEL OF FOLLOWING CONTROLS/INSTRUMENTS

a. Orifice plate

b. Expansion valve

c. Float switch

d. Flow switch

e. Airstat

f. Pressure gauge

g. Thermometer

h. Static pressure gauge

j. Electronic thermometer

k. Temperature indicator

14. VARIABLE SPEED FREQUENCY DRIVE FOR AHU

a. Make / Country of Origin

b. Model No.

c. Type
d. Motor Rating

e. Rated Current

f. Maximum Output

g. PID Controller

h. Interface with BAS.

i. Hormonic filter built-in (Confirm)

j. Fault Indication.

k. Dimensions (mm)

l. No. of Steps

m. Operating Weight

5.2.1.4

5.2.1.5 WATER PIPING

5.2.1.5.1 a. Make of pipes / class of pipes

b. Pipe Wall thickness

c. VALVES & STRAINER

5.2.1.6

i. Butterfly valves

ii. Gate valve
iii. Globe valve
iv. Check valve
v. Ball valve
vi. Ball valve with strainer
vii. Balancing valve
viii. Pot Strainer
ix. Y-Strainer
d. Pressure Gauge
   i. Make
   ii. Range
   iii. Dial Size
e. Thermometer (Make/Type & Range)
f. Flow Meter
   i. Type and Make
   ii. Size of flow meter
g. Make of Manometer

16. **GALVANISED STEEL SHEETS**

   a. Make
   b. Thickness/Gage
   c. Class of Galvanizing

5.2.1.7

5.2.1.8 17. **GRILLES / DIFFUSERS / DAMPERS**

Make, material and gauge of the following:

a. Fire damper, rating, make of damper motor
b. Smoke damper, rating, make of damper motor
c. Grilles/Diffuser
d. Slot Diffuser

e. Duct Damper

f. FA Damper

g. Access Panel.

18. **INSULATION**

a. Manufacturer

b. Duct acoustic lining material & density

c. Duct insulation material & density

d. Pipe insulation material & density

19. **VIBRATION ISOLATION SYSTEM**

a. Manufacturer

b. Type

c. Stiffness coefficient and Deflection

d. Vibration isolation efficiency (%)

e. Material of flexible connection at

i. Pumps

ii. Chillers

iii. Expansion Joints
5.2.1.9
20. VARIABLE AIR VOLUME

a. Make / Country of Origin

b. Model No.

c. Type

d. Material

e. Gauge

f. Pressure Drop

g. Noise Level

21. TESTING AND BALANCING EQUIPMENT

a. Name of the Agency

b. Furnish the complete list of equipment to be used on this Project.
# APPENDIX – IV

## 6.1 LIST OF BUREAU OF INDIAN STANDARDS CODES

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 554 - 1985 (Reaffirmed 1996)</td>
<td>Dimensions for pipe threads where pressure tight joints are required on the threads.</td>
</tr>
<tr>
<td>IS : 694 - 1990 (Reaffirmed 1994)</td>
<td>PVC insulated (HD) electric cables for working voltage upto and including 1100 volts.</td>
</tr>
<tr>
<td>IS : 780 - 1984</td>
<td>Sluice valves for water works purposes.</td>
</tr>
<tr>
<td>IS : 1239 (Part - I) - 1990</td>
<td>Mild steel tube</td>
</tr>
</tbody>
</table>
IS : 1239 (Part - II) - 1992 Mild steel Tubulars and other wrought steel pipe fittings.

IS : 1255 - 1983 Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)

IS : 1554 - 1988 (Part – I) PVC insulated (Heavy Duty) electric cables for working voltages pto and including 1100 volts.

IS : 1897 - 1983 (Reaffirmed 1991) Copper bus bar / strip for electrical purposes

IS : 2379 - 1990 Colour code for the identification of pipelines.

IS : 2551 - 1982 Danger notice plate


IS : 5133 - 1969 (Part-I) (Reaffirmed 1990)  
Boxes for the enclosure of electrical accessories.

IS : 5216 - 1982 (Part-I) (Reaffirmed 1990)  
Guide for safety procedure and practices in electrical work.

IS : 5312 (Part-I) - 1984 (Reaffirmed 1990)  
Swing - check type reflux Non return valves for water works

IS : 5424 – 1989 (Reaffirmed 1994)  
Rubber mats for electrical purposes.

IS : 5578 & 11353-1985  
Marking and identification of conductors

IS : 6392 - 1971 (Reaffirmed 1988)  
Steel pipe flanges.

IS : 8623 - 1993  
Low voltage switchgear and control gear Assemblies (Requirement for type / partly type tested assemblies)

IS : 8623 - 1993 (Part - II)  
Bus Bar trunking system

IS : 8828 - 1996  
Circuit Breakers for over current protection
For house hold and similar installation.

IS : 9537 - 1981 (Part II)  
Rigid Steel Conduits for electrical wiring


IS : 13947-1993 (Part-II)  Circuit Breakers
IEC 947 - 2

IS : 13947 - 1993 (Part-III)  Switches, disconnectors and fuse for low voltage switch gear and control gear.

IS : 13947 - 1993 (Part-IV)  Low voltage switch gear and control gear for contactors and motor starters


BS : EN:779 – 1993  Filters


Fundamentals 2013
Systems & Equipment 2016
Application 2016
Refrigeration 2014
ASHRAE 90.1-2016
ASHRAE 55-2004
ASHRAE 52.1 and 52.2
ASHRAE Indoor air quality Standard 62.1-2010
Energy Conservation Building Code(ECBC 2017)

IEC Relevant Sections.

Basis of Design:

Site Location : Balasore, Odisha
Geographic location : Latitude 28.24 deg. N; Longitude 77.19 deg. E
Altitude : 293 M above mean sea level.

1.1 Outdoor Design Conditions.

Outdoor Design Conditions for Balasore (As per NBC-2016) data have been considered as
follows:-

Summer
Dry Bulb Temperature : 101.5 Deg.F (38.6 Deg. C)
Mean Coincident Wet Bulb Temperature : 80 Deg F (26.6 Deg. C)

Monsoon
Wet Bulb Temperature : 84.2 Deg F (29 Deg. C)
Mean Coincident Dry Bulb Temperature : 93.4 Deg F (34.1 Deg. C)

Winter
Dry Bulb Temperature : 59 Deg.F (15.1 Deg. C)
Mean coincident Wet Bulb Temperature : 57.2 Deg F (14 Deg. C)

1.2 Filtration

Three type of filtration efficiencies have been considered depending on the requirement which
is identified in table 2.4 and are as follows:-

a. Three stages of filtration consisting of Pre-filter (MERV-8), Microvee(MERV-13) & HEPA filters upto 0.3 micron particle size.

b. Two stages of filtration consisting of Pre-filter (MERV-8), Microvee(MERV-13) filter upto 5 micron particle size.
c. One stage of filtration consisting of normal washable filters upto 10 micron particle Pre-filter (MERV-8), size.
1.3 Inside Design Conditions & Ventilation requirement for AC Areas.

Based on past experience of similar projects or as per ASHRAE & NABH standards, indoor design conditions & minimum fresh air quantities considered in different areas are as follows:-

<table>
<thead>
<tr>
<th>Area / Room</th>
<th>Design Temp. (deg.C)</th>
<th>Relative Humidity (%)</th>
<th>Min. total ACPH</th>
<th>Fresh Air ACP H</th>
<th>Air Pressure in relation to adjacent area</th>
<th>Recirculation of Air</th>
<th>No. of stages of filtration</th>
<th>Type for Filters for Each Filtration Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURGERY AND CRITICAL CARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Room/LCS OT</td>
<td>18-22</td>
<td>20-60</td>
<td>20</td>
<td>4</td>
<td>Positive</td>
<td>No</td>
<td>3</td>
<td>HEPPA Filter, MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Sterile (Clean) Corridor</td>
<td>21-24</td>
<td>30-60</td>
<td>6</td>
<td>2</td>
<td>Negative</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>ICU/MICU/NICU/PICU</td>
<td>21-24</td>
<td>30-60</td>
<td>6</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Treatment Rooms</td>
<td>21-24</td>
<td>30-60</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Anesthesia Gas Storage</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>-</td>
<td>Negative</td>
<td>No</td>
<td>N/R</td>
<td></td>
</tr>
<tr>
<td>CSSD</td>
<td>20-24</td>
<td>30-60</td>
<td>12</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Emergency</td>
<td>21-24</td>
<td>30-60</td>
<td>12</td>
<td>2</td>
<td>Negative</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Procedure Room</td>
<td>21-24</td>
<td>30-60</td>
<td>15</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Delivery Room</td>
<td>21-24</td>
<td>30-60</td>
<td>15</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>NURSING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>Negative</td>
<td>No</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>DIAGNOSTIC &amp; TREATMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray</td>
<td>21-24</td>
<td>Max 60</td>
<td>15</td>
<td>3</td>
<td>Positive</td>
<td>Yes</td>
<td>1</td>
<td>MERV-8</td>
</tr>
<tr>
<td>USG</td>
<td>21-24</td>
<td>Max 60</td>
<td>15</td>
<td>3</td>
<td>Positive</td>
<td>Yes</td>
<td>1</td>
<td>MERV-8</td>
</tr>
<tr>
<td>CT/MRI</td>
<td>20-24</td>
<td>Max 60</td>
<td>12</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Clinical Laboratory / Blood Bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Laboratory</td>
<td>21-24</td>
<td>30-60</td>
<td>6</td>
<td>2</td>
<td>Negative</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Sterilizer Equipment</td>
<td>24±1</td>
<td>30-60</td>
<td>10</td>
<td>-</td>
<td>Negative</td>
<td>Yes</td>
<td>1</td>
<td>MERV-8</td>
</tr>
<tr>
<td>Sterile Storage</td>
<td>22-26</td>
<td>Max 60</td>
<td>4</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>1</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
<tr>
<td>Radiology</td>
<td>21-24</td>
<td>Max 60</td>
<td>12</td>
<td>2</td>
<td>Positive</td>
<td>Yes</td>
<td>2</td>
<td>MERV-8 &amp; MERV-13</td>
</tr>
</tbody>
</table>
### 1.4 Mechanical Ventilation

<table>
<thead>
<tr>
<th>Area / Room</th>
<th>Design Temp.</th>
<th>Relative Humidity</th>
<th>Min. total ACPH</th>
<th>Fresh Air ACPH</th>
<th>Air Pressure in relation to adjacent area</th>
<th>Recirculation of Air</th>
<th>No. of stages of filtration</th>
<th>Type for Filters for Each Filtration Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>Negative</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>House Keeping Closet/Nap</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>Negative</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Toilet (Private)** 6 ACPH
**Toilet (Public)** 12 ACPH
**Stores** 6 ACPH
**AC Plant** 15 ACPH
**STP Ventilation** 30 ACPH Minimum
**Laboratories** 6-12 ACPH
**Kitchen Ventilation** 30 ACPH assumed or as per kitchen consultant requirement
**Pump Room** 15 ACPH
**Electrical Room** 15 ACPH
**Corridor Ventilation** 12 ACPH
**Lift well pressurization** To be mechanically pressurized for maintaining 50 Pa
**Lift lobby pressurization** To be mechanical pressurized for maintaining 30 Pa.
**Staircase Pressurization** To be mechanical pressurized for maintaining 30 Pa.
**Staircase / Lift lobby Pressurization** Natural Ventilation – If open, clear area of 0.5 sq.mt is provided on each landing in addition to 0.5 sq.mt of opening on topmost level then mechanical ventilation is not required.

*Note: Separate exhaust duct shall be provided for toilets, pantries, and dirty utility and isolation areas. These shall not be combined with each other or with any other exhaust ducts of AC system.*

### 1.5 Building Construction Data (As per ECBC-2017)

In accordance with Energy Conservation Building (ECBC) Balasore comes under Warm & Humid climate zone. Hence, based on the ECBC norms, U Values considered are as follows:-
Roofs (ECBC compliant)

Roofs shall comply with the maximum assembly U-factors. The roof insulation shall be applied externally as part of structural slab and not as a part of false ceiling.

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>Maximum U-factor of the overall assembly ((W/m^2\cdot{\circ}C)/(BTU/ft^2\cdot{\circ}F))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm &amp; Humid</td>
<td>U-0.20/U-0.035</td>
</tr>
</tbody>
</table>

Opaque Walls (ECBC compliant)

Opaque above grade external walls shall comply with the maximum assembly U-factors:-

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>Maximum U-factor of the overall assembly ((W/m^2\cdot{\circ}C)/(BTU/ft^2\cdot{\circ}F))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm &amp; Humid</td>
<td>U-0.40/U-0.071</td>
</tr>
</tbody>
</table>

Vertical Fenestration (ECBC compliant)

For Warm & Humid, vertical fenestration compliance requirements for ECBC Complaint shall comply with the following:

(a) Maximum allowable Window Wall Ratio (WWR) is 40% (applicable to buildings showing compliance using the Prescriptive Method, including Building Envelope Trade-off Method)

(b) Minimum allowable Visual Light Transmittance (VLT) is 0.27

(c) Assembly U-factor includes both frame and glass area weighted U-factors.

(d) Assembly SHGC includes both frame and glass area weighted SHGC.
Vertical fenestration shall comply with the maximum Solar Heat Gain Coefficient (SHGC) and U-factor requirements as per table given below:-

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>WWR=40%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum U-factor</td>
</tr>
<tr>
<td></td>
<td>(W/m²°C)/(BTU/ft²°F)</td>
</tr>
<tr>
<td>Composite</td>
<td>3.0/0.53</td>
</tr>
</tbody>
</table>

**Note**:–
1. The above values shall be fine-tuned based on the energy simulation outputs and/or based on the actual selection of Glass by Architect or Client in case building is not certified.

2. Type & thickness of thermal insulation shall be finalized based on the wall & roof construction details in consultation with the Project Architects and the U-values shall be finalized accordingly.

### 1.6 Design Parameters

#### 1.6.1 Water Chilling Machine

Performance rating of the water chilling machine shall be based on the following design parameters:-

- **Temperature of chilled water entering chiller**: 54° F (12.2° C)
- **Temperature of chilled water leaving chiller**: 44° F (6.67° C)
- **Fouling factor for chiller in FPS unit**: 0.0005 FPS
- **Temperature of condenser water entering condenser**: 92° F (33.33° C)
- **Temperature of condenser water leaving condenser**: 102° F (38.88° C)
- **Fouling factor for condenser in FPS unit**: 0.001 FPS
COP As per ECBC-2017 required as AHRI Condition : 5.4

IPLV at AHRI Condition : 6.5

Refrigerant : R-134a

<table>
<thead>
<tr>
<th>Chiller Capacity (kW)</th>
<th>COP</th>
<th>IPLV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;260</td>
<td>4.7</td>
<td>5.8</td>
</tr>
<tr>
<td>≥260 &amp; &lt;530</td>
<td>4.9</td>
<td>5.9</td>
</tr>
<tr>
<td>≥530 &amp; &lt;1,050</td>
<td>5.4</td>
<td>6.5</td>
</tr>
<tr>
<td>≥1,050 &amp; &lt;1,580</td>
<td>5.8</td>
<td>6.8</td>
</tr>
<tr>
<td>≥1,580</td>
<td>6.3</td>
<td>7.0</td>
</tr>
</tbody>
</table>

1.6.2 Design parameter for selection of Air Handling Unit and its components shall be as follows:-

- Maximum face velocity across pre-filters & MERV 13 filters : 100 M/Min
- Maximum face velocity across cooling coils : 150 M/Min
- Maximum fan outlet velocity : 550 M/Min

Maximum fan speed *

a. Fan above 300 mm dia : 900 RPM
b. Fans upto and including 300 mm dia : 1440 RPM

Maximum fan motor speed : 1450 RPM
*Note: Fan speed limitations above are for general guidelines and not at the expense of fan efficiency. Higher speeds may yield more efficiency in few cases (like OT AHUs or AHUs with HEPA filters). In such cases higher efficiency shall be criterion for fan selection.

1.6.3 Piping shall be sized for the following design parameters:-

- Maximum velocity : 2.5 M/Sec
- Maximum friction : 4 M/100 M Run

1.6.4 Ventilation Fan

- Maximum fan outlet velocity for fan upto 450 mm dia : 9.14 m/sec (1800 fpm)
- Maximum fan outlet velocity for fan above 450 mm dia : 12 m/sec (2400 fpm)
- Maximum fan speed for fans upto 450 mm dia : 1440 RPM
- Maximum fan speed for fans above 450 mm dia : 1000 RPM

1.6.5 Duct Design

- Maximum flow velocity in ducts for air conditioning : 7.5 m / sec (1500 fpm)
- Maximum flow velocity in ducts for ventilation in pump room, toilet exhaust : 7.5 m / sec – 12.5 m / Sec (1500 – 2500 FPM)
- Maximum friction : 0.65 Pa / M run (0.08 inch WG/100 ft run)

1.7 Estimated Air Conditioned Load

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>SPACE</th>
<th>Air Conditioning Area (Sq.Ft)</th>
<th>Air Conditioning Load (TR)</th>
<th>Equipment Selection As Per Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A)</td>
<td>Ground Floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Equipment Quantity</td>
<td>Equipment Cost</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------</td>
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<tr>
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<td>Emergency Block</td>
<td>11836</td>
<td>70</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Air Handling Units/Fan Coil Units</td>
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</tr>
<tr>
<td>2</td>
<td>Blood Bank</td>
<td>2765</td>
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<td></td>
<td>Air Handling Units/Fan Coil Units</td>
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<tr>
<td>3</td>
<td>MRI/CT/X Ray/UPS Etc.</td>
<td>11836</td>
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<td>Air Handling Units/Fan Coil Units</td>
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<tr>
<td>4</td>
<td>Labour Room/Gynae OT etc.</td>
<td>11836</td>
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<tr>
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<td></td>
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<td>Air Handling Units/Fan Coil Units</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td>38273</td>
<td>225</td>
<td></td>
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<tr>
<td>B) First Floor</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>NICU/PICU/Nurse/Doctor Duty Room</td>
<td>7000</td>
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<td>Air Handling Units/Fan Coil Units</td>
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<tr>
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<td>Central Lab</td>
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<td>3</td>
<td>Minor OT</td>
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</tr>
<tr>
<td>C) Second Floor</td>
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<td></td>
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<tr>
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<td>CSSD Area</td>
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<tr>
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<td>Air Handling Units/Fan Coil Units</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RICU/BICU/Doctor/Nurse Room</td>
<td>11836</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Air Handling Units/Fan Coil Units</td>
<td></td>
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<td>3</td>
<td>2 No. Minor OT/ Diagnostic Room</td>
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<tr>
<td>D) Third Floor</td>
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<tr>
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<td>Administration area (SUPERINTENDENT ROOM)</td>
<td>1000</td>
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</tr>
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<td></td>
<td><strong>Total</strong></td>
<td>1000</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>E) Fourth Floor</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>6 No. OT Block</td>
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<td>75</td>
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<td></td>
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<td>Air Handling Units/Fan Coil Units</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>Mortuary</td>
<td>4300</td>
<td>25</td>
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<tr>
<td></td>
<td>BMW</td>
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<tr>
<td></td>
<td><strong>Grand Total</strong></td>
<td>75405</td>
<td>519</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diversity@85%</td>
<td>441</td>
<td>3 No. 250 TR Water Cooled Screw Chillers</td>
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</tbody>
</table>

1.8 System Description

1.8.1 Central Air Conditioning System

A central air conditioning system shall be designed to provide year round thermal environmental control for the entire medical facilities such as patient rooms, patient corridor, Intensive Care Units (ICUs), Operating rooms etc., Air conditioning shall be provided by a central variable flow chilled water recirculation system for maximum energy conservation.
The central air conditioning system shall consist of water chilling units, multiple primary chilled water pumps, Secondary Chilled Water, condensing water pumps, Electric Hot water generator, Hot water Pumps, FRP (Fiber Reinforced Plastic) induced draft cooling towers, air handling units and fan coil units, chilled, and condensing water piping with accessories, air distribution system, insulation, electrical panels, wiring, control wiring and earthing.

The building Cooling loads and block loads shall be simulated on HAP E-20-II software. As per preliminary air conditioning load is estimated above Point No. 2.4.

However, the capacity of Central Cooling plant shall be based on the actual load calculations.

Chilling units and hot water generators shall be housed in the air conditioning plant room at Service Block at site level. Chilled water from chilling units shall be pumped through various insulated chilled water pipes, each dedicated for a particular zone, installed in the ceiling spaces within plant room and adjoining areas.

*Four pipe systems shall be provided for the Critical Area in Hospital. With this arrangement, we shall be able to maintain the precise control of relative humidity during monsoon season in critical areas.*

Chilled water system shall be designed for balancing water flow through balancing valves shall be installed in major branch pipes, Risers and at each AHU for fine tuning at the time of final balancing of the chilled & hot water system. All pipes within plant room shall be supported off the floor to avoid transmission of vibration to ceiling slab and occupied floors above.

Also to take care of expansion / contraction in hydronic circuit, pressurized expansion tank along with air separator shall be provided in the plant room.

All mechanical equipment such as chilling units, pumps, AHU’s and larger ventilation fans shall be provided with energy efficient motors in order to attain energy savings, since all these equipment shall operate for extended periods of time.

Cooling towers for air conditioning system shall be selected for minimum drift losses and minimum noise, and shall be installed on Terrace. These shall be FRP construction induced draft type. Also to take care of expansion / contraction in hydronic circuit, pressurized expansion tank along with air separator shall be provided in the plant room. Cooling tower motors shall be provided with Variable Frequency Drive (VFD) to conserve energy during periods of low ambient wet bulb temperature as cooling towers shall operate round the clock (365 days a year).
Operating the motor through VFD shall save energy by operating the cooling tower fan at 30-100% speed, thus conserving motor BHP. The speed shall vary in response to ambient wet bulb temperature and cooling tower leaving water temperature.

All mechanical equipment such as chilling units, pumps, AHU’s and larger ventilation fans shall be provided with energy efficient motors in order to attain energy savings, since all these equipment shall operate for extended periods of time.

1.8.2 Chilled Water Generation & Distribution (Variable speed)

Central air conditioning shall be designed for maximizing energy conservation provided by a Central Variable flow chilled water distribution system for maximum energy conservation. Secondary chilled water pumps shall be provided with variable speed drive to achieve variable water flow in each chilled water zone. Chilled water flow in load circuits shall be varied but the same through chillers shall remain constant. By measuring the pressure differential between chilled water supply and return header, the speed of secondary chilled water pumps shall be automatically varied, thus conserving pump brake horse power. The main advantage of this system shall be that the circulation of chilled water through the entire nursing home shall be avoided, and chilled water shall be supplied in each area according to air conditioning load demand.

Typical Chilled Water Schematic
1.8.3 Pipes

Chilled water shall be pumped through pipes running into vertical risers installed in pipe shafts within building. All pipes shall be supported in a manner, which will avoid transmission of vibration to slab and occupied floors. Chilled water pipes shall be insulated.

1.8.4 Air Handling Units

Double skin (for noise control) air handling units consisting of centrifugal fan (direct Driven), cooling coil and filter section shall be provided for each area. Chilled water supply and return headers shall be tapped and connected to cooling coils. Supply air ducts shall be installed in ceiling spaces. Conditioned supply air shall be discharged through supply air grilles and diffusers. Return air shall be taken back to the air handling unit room generally through return air ducts, or through ceiling spaces (where return air duct is not possible).

Selected areas as defined in earlier section of report shall be provided with 2 stage filtration i.e. pre filters and microvee filters. All ICUs and recovery areas shall have provision for temporary 100% exhaust to flush the room in case of vomiting by any patient. Control of motorized damper & exhaust fan shall be provided at Nurses Station. Same Exhaust fan can be used in case of fire to extract smoke.

All Floor Mounted AHU Shall be provided with Mixing box & Thermal Break Profile.

All AHU, s shall be provided with motorized fire dampers in both supply & Return Duct.

1.8.5 Operation theatre design:-

Air conditioning system for operation theatre shall be designed by considering following objectives
• To control the concentration of harmful bacteria

• To prevent infiltration of less clean air into the operating theatre

• To create an air flow pattern that carries contaminated air away from the operating table

• To provide a comfortable environment for the patient and operating team

• To ensure uninterrupted operations

• To save energy

All Operation Theaters shall be provided with independent Recirculation type AHU. Supply air with three (Pre-Filter + Microvee + HEPA Filters) stages of air filtration up to 0.3 microns particle size. Air distribution within theatres shall be designed for laminar flow with return air picked-up from floor level & return to mixing box (Return Air + Fresh Air). For RH control Heating Coil is proposed. For de-fumigation (i.e. exhausting 100% air) shall be provided for all OT,s.

These AHU’s shall be capable of delivering air at high static for overcoming pressure drop in various filtration stages. The dehumidified cool air shall be discharged within OT from the plenum through multiple 150 mm deep terminal HEPA filters (provided by the OT supplier) at approximately 0.5 mps (90 feet per minute) velocity. Laminar air flow pattern shall be created by collecting the return air at 300 mm above finished floor level.

OT AHU Shall be provided with variable frequency drive for both supply & return.
1.8.6 Infectious Isolation rooms

The infectious isolation room protects the rest of the hospital from patient's infectious diseases.

Airflow rates in the infectious isolation room shall be as per area requirement. Separate AHU is not required for these isolation rooms. Supply air shall be tapped from nearest AHU. However, no return shall be taken from these rooms. All air shall be exhausted to the atmosphere. Pressure to be maintained in the room is negative pressure w.r.t surrounding.

1.8.7 Intensive Care Unit (ICU)

ICUs shall be air-conditioned for 24 Hrs. ICU AHU shall be provided with 2-stage filtration Heating Coil shall be provided for humidity control. Defumigation facility (i.e. exhausting 100% air) shall be provided for ICUs. This can be also used when inmates are in any kind of distress (i.e. due to vomiting). Nurse station shall be provided with push button for exhausting 100% air from ICU. During this period, inside temperature conditions in the ICU will be disturbed from the designed values. Same Exhaust fan can be used in case of fire to extract smoke. ICU AHU Fan Shall be direct driven Fan type.

1.8.8 CSSD

For CSSD Area Provision of Electrical Point shall be left for split units.

1.8.9 Pantry and Toilet Exhaust

Pantries and toilets shall be connected to the centralized mechanical ventilation system consisting of in-line fan in exhaust duct.

1.8.10 Pressurization

Pressurization system, consisting of supply air fans installed on roof top. This fan shall be connected to supply air ducts installed in vertical risers for supplying air at each staircase landing for achieving effective pressurization. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. Supply air fans serving stairwell shall be provided with motorized damper at fan discharge to prevent humid fresh air entering into staircase well. These dampers shall be
interlocked with fan motor and shall open upon getting signal from the smoke sensor.

Lift wells shall also be provided with pressurization by supplying the air through supply air fans installed on roof top. The pressurization fans shall get activated upon sensing of smoke in General ward corridors / common passengers / lift lobby.

1.8.11 Server Room Air Conditioning

Air conditioning of server room shall be through chilled water based AHUs/FCU. The system shall operate on chilled water during day and night time. The AHUs shall be placed free standing against the external wall of Server Room. In view of critical operation, air cooled DX type units shall also be installed to cater for operation during winters and also for standby operation. Condensate from all AHUs and indoor DX units shall be piped straight outside the Server Room.

1.8.12 Critical Area Like (ICU, SICU etc.)

All Critical Area, slike ICU, s Ward Rooms etc) shall be smoke extracted using same exhaust fan proposed for de-fumigation. Which can be operated by sensing smoke through the smoke censor & fan hould operate accordingly. These fans also shall be integrated with BMS system if BMS is their.

1.8.13 UPS / EPABX Room Air Conditioning

Chilled water air handling unit shall be installed for air conditioning of EPABX room. In addition, DX standby split unit for operation during winter shall also be installed. Ventilation shall be considered for UPS room.

8.14 Duct Construction and Fire Safety

All ducts shall be fabricated out of galvanized sheet steel (GSS) as per SMACNA standard for long life and as per fire
norms.

Type of Ducts as shown above

1.8.15 Mechanical Ventilation System for Plant Rooms

All plant rooms shall be provided with mechanical ventilation system. The system shall consist of fans, outdoor air grilles with filters, air distribution system with grilles, electrical panel, power cabling, control wiring and earthing. Filtered outdoor air shall be drawn from outside and supplied to mechanically ventilated areas by means of grilles and equivalent amount shall be exhausted out.

1.8.16 Kitchens

Kitchen shall be provided with evaporating air cooling system for supply air. The air washer shall be celldak fill type giving 90% efficiency at 350 fpm air velocity. The system shall be complete with air distribution system, electrical panel with control wiring & earthing. Kitchen hoods over cooking area of main kitchens shall be compensating type. All kitchens hoods shall be provided with makeup air approx. @ 80%. Balance air shall be through adjoining spaces. However, cooking areas shall be exhausted as per Facility Planning Consultant’s inputs. The exhaust shall be collected from the kitchen hoods and shall be connected to Ecological Unit (ECU) as per requirement of local pollution board. Greasy air shall pass through various sections and clean air shall be exhausted to atmosphere. Kitchens shall be maintained at slight negative pressure to prevent spread of food smell in adjacent occupied areas.
2. WATER CHILLING MACHINE

2.1 SCOPE

The scope of this section consists of but is not necessarily limited to the following:

a. Manufacture and supply of Screw liquid chillers with associated motors, starter and accessories.

b. All associated items herein to be supplied delivered and installed.

c. In case of multiple compressors, distribution panel having one incoming and multiple outgoings (equal to number of compressors) along with cabling from panel to compressors/motors. Incoming power cable will be of Aluminum. Necessary hardware to connect incoming Aluminum cable to chiller copper cabling shall be included.

d. Assembly of chiller components including connection of cooler, condenser, motor, compressor, purge system for low pressure machine etc. into complete refrigeration machine.

e. Provide manufacturer’s factory representative’s services, including coordination, and start-up and erection & testing supervision.

f. Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.

g. Carry out performance test run at site.

2.2 QUALITY ASSURANCE PROGRAMME

b. Chiller shall be the product of a manufacturer / license normally supplying this type of equipment and who can show evidence, having completed five installations of approximately the same capacity that have been in successful operation for at least five years.

c. The chiller shall be designed/manufactured and tested in accordance with the applicable portions of the latest revisions of the following Standards and Codes.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHRI 550 / 590</td>
<td>Performance rating of water chilling packages using the vapor compression cycle.</td>
</tr>
<tr>
<td>AHRI 575</td>
<td>Air Conditioning and Refrigeration Institute. Standard Method of Measuring Machinery Sound Within Equipment Rooms (Basis of all data presented or field testing of equipment, with relation to sound requirements).</td>
</tr>
<tr>
<td>ASME CODE</td>
<td>American Society of Mechanical Engineers. (Div. 1 Code for Unfired Pressure Vessels - Section VIII, Design, construction, testing and certification of pressure vessels).</td>
</tr>
<tr>
<td>ANSI-B9.1</td>
<td>American National Standards Institute. Safety Code for Mechanical Refrigeration (overall general safety requirements, relief device sizing, etc.)</td>
</tr>
<tr>
<td>TEMA</td>
<td>Tubular Exchanger Manufacturer’s Association.</td>
</tr>
<tr>
<td>ISO R281</td>
<td>Rolling Bearings – Dynamic Load Ratings and Rating Life</td>
</tr>
</tbody>
</table>
2.3 CAPACITY

Actual refrigeration capacity of chilling machine shall be as shown on Drawings and in Schedule of Quantities.

2.4 SCREW COMPRESSOR

a. The compressor shall be single / multiple stage, open / hermetic type, using Refrigerant-HFC 134 a. The impeller shaft shall be direct. It shall be self-aligned and balanced and shall be assembled in the compressor casing. The driven end of the gear shaft shall be connected with the motor through a flexible coupling. The impeller shall be cast from alloy steel / aluminum alloy. This shall be statically and dynamically balanced to ensure vibration free operation. Casing design shall ensure that major wearing parts, bearings thrust bearings are accessible for maintenance and replacement. Condensed liquid refrigerant shall be injected into the compressor discharge to reduce discharge gas temperature and to reduce sound level of the compressor.

b. Bearings

The compressor shall incorporate the necessary design features which eliminate both the axial and radial thrust. Bearings shall be fabricated of aluminum alloy/white metal and precision bored and axially grooved. The bearings shall be pressure lubricated during operation and shall be completely sequenced and interlocked with the startup of the machine in such a way that the oil pump should start earlier than the machine and the machine should automatically start after some time provided the oil temperature and pressure is maintained during the start-up period. On stopping the machine, oil pump should stop only after the machine has completely stopped.

c. Lubrication System

The lubrication system shall form one integral part of the compressor assembly and shall enforce complete force feed lubrication (at a controlled pressure and controlled temperature) to all bearing surfaces under any speed conditions, at start-up, at shut down & during operation at various loads. Provision shall also be made to take care of lubrication during coast down cycle upon intermittent failure of power. Thus full
lubrication must be available to the machine during acceleration and deceleration periods. Further it should include the following:

i. High efficiency oil filters.

iv. Low oil pressure cutout.

v. Oil coolers and oil heaters (with built-in-thermostat) to aid maintaining constant temperature.

iv. Oil level indicator.

v. Oil pressure control with pressure gauges and thermometer.

During operation an oil film under pressure should prevent outward leakage of refrigerant.

Oil cooler shall be in built part of chiller package. Oil cooler shall be shell & tube / PHE type.

d. **Capacity Control**

The compressor shall be equipped with an automatic suction damper or inlet guide vanes control for regulating its capacity. The positioning of the damper shall be done by means of thermostatically actuated electronic temperature-controller differential-type with its sensing element or elements in the outgoing chilled water lines. The automatic damper will maintain the constant temperature of chilled water. It should be possible to go down to 20% of full load at both Constant Condenser water entering temperature & AHRI Conditions, with nearly linear reduction in power input to the chilling machine.

Compressor and motor sole plates, anchor bolts and sleeves and necessary vibration isolation pads shall be included.
e. **Microprocessor Control Centre**

Each unit shall be furnished with microprocessor control center in a locked enclosure, factory mounted, wired and tested. The control center shall include Touch screen – Graphical Type display showing all system parameters in English language with numeric data in English (FPS) units.

Digital programming of essential set points through a color coded, tactile-feel keypad shall include: entering and leaving chilled water temperature and condensing water temperature; percent loading; pulldown demand limiting; seven-day time clock for starting and stopping chiller (complete with local holiday schedule); and remote reset temperature range.

All safety and cycling shutdowns shall be annunciated through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include: high oil pressure; high compressor discharge temperature; low evaporator pressure; motor controller fault; and sensor malfunction. Cycling shutdowns shall include: low water temperature; low oil temperature: chiller/condenser water flow interruption; power fault; internal time clock; and anti-recycle.

System operating information shall include: return/leaving chilled water temperatures; return/leaving condenser water temperatures; evaporator /condenser refrigerant pressure; differential oil pressure; percent motor current; evaporator/condenser saturation temperatures; guide vane position, operating hours(Hours Run) and number of compressor starts, purge unit operation, compressor motor current and fault history.

Security access shall be provided to prevent unauthorized change of set points to allow local or remote control of the chiller, and to allow manual operation of the pre-rotation vanes and oil pump.

The chiller shall be provided with an RS-232/485 port to output all system operating data, shutdown/cycling messages and a record of the last four cycling or safety shutdowns to a remote printer or Building Automation System (BAS). The control center shall be programmable to provide data logs to the BAS/printer at a set time interval.
The chiller control panel shall be able to interface with the Building Automation System (BAS) to provide remote chiller start/stop, reset of chilled water temperature, reset of current limit; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset, and chiller is shut down on a recycling safety. Control panel should be with open protocol like Modbus /Bacnet for integrating with BAS.

2.5 INTERFACE WITH BUILDING AUTOMATION SYSTEM

All necessary hardware’s / software’s to integrate the chiller panel to BAS system shall be provided free of cost by chiller manufacturer / supplier.

For the integration of Microprocessor Panel of the chilling machine with the Building Automation System, an Interface Control Document shall be developed by BAS Contractor.

It shall be responsibility of HVAC Contractor to provide following to BAS Contractor for preparing the interface.


b. Software Protocol of Chiller Microprocessor panel.

c. Communication structure relating to collection of message / event information.

d. Description of the formatted packets / blocks of data which construct controller commands / responses.

e. Written permission to BAS contractor to develop the interface without any financial implication.

2.6 ELECTRIC MOTOR
a. The main electric motor and drive shall be furnished by chilling machine manufacturer in order to ensure system compatibility and drive train optimization. Motor shall be either IP 54 or IP55 only. Motor system shall be suitable for 415±10% volts, 3 phase, 50 cycles AC supply. Motor shall be squirrel cage induction type. The motor shall be suitable for load characteristics and the operational duty of the driven equipment, and comply with these specifications and latest IEC codes.

The VFD shall be provide with Active harmonics Filter and shall be of IP 54 Rating (UL Listed & CE Type only). THDI & THDV not to expect 5% at source for VFD.

The efficiency and power factor shall be not less than the following values, at rated voltage and frequency and at the specified loads.

<table>
<thead>
<tr>
<th>Load</th>
<th>Efficiency</th>
<th>Power Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Load</td>
<td>96%</td>
<td>0.86</td>
</tr>
<tr>
<td>3/4</td>
<td>96%</td>
<td>0.8</td>
</tr>
<tr>
<td>1/2</td>
<td>96%</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Starting current at rated voltage and frequency shall not exceed 2 times the full load current at the rated voltage and frequency. The total efficiency shall include losses of the auxiliaries such as independent excitation, motor-driven fans, lube-oil pumps etc. Over voltage surge protection shall be provided to protect motor.

The motor shall be capable of successful operation when running at rated load with variations in voltage and frequency as follows:

i. Within ± 10% of rated voltage with rated frequency.

ii. Within ± 5% of rated frequency with rated voltage.

b. Combination variation in voltage and frequency of 10% (sum of absolute values) of the rated values, the frequency variation not exceeding ± 5% of rated frequency.
Terminal box of sturdy construction shall provide enough space for terminating, connecting and earthing of PVC/XLPE - insulated aluminum conductor cable. All terminal boxes shall be located at the same side of the motor and have terminal and cable glands suitable for cables specified.

c. Motor shall include following accessories and features:

i. Temperature detector in stator windings.

ii. Platinum resistance temperature detector for bearing temperature.

2.7 **DRIVE**:

The compressor shall be driven directly or through speed increasing gears as required. The gears and pinions shall be pressure lubricated. The gears shall be provided with oil filter and submerged oil pump. The gears should be of helical type with crown teeth designed such that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears should be integrally assembled in the compressor rotor support and be film lubricated. Each gear should be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor shafts.

2.8 **ECONOMISER SUBCOOLER**

Each chiller shall be provided with shell and tube / PHE / flash chamber type economizer. Condensed liquid in condenser shall be taped off and shall be expanded at intermediate pressure with expansion valve. Value of intermediate pressure (Pi) shall be as follows.

\[
Pi = (Pc Pe)^{0.5}
\]
Where \( P_c = \) saturated condensing pressure (abs)

\( P_e = \) Saturated Evaporation Pressure (abs)

The liquid expanded to intermediate pressure shall be used to absorb enthalpy from remaining liquid refrigerant in order to provide sub cooling. Vapor refrigerants due to above heat transfer shall again be admitted to compressor at intermediate pressure port.

2.9 EVAPORATOR AND CONDENSER

a. Shells and Water Boxes

The evaporator and condenser shells shall be of rolled carbon steel plate with fusion welded seams. Removable compact hinged type water boxes of cast iron or welded steel with stub-out water connections shall be provided to permit access for tube cleaning and replacement. Water boxes shall be designed for 150 psig working pressure and hydraulically tested at 225 psig. The tubes shall be finned from outside having spiral ridges from inside, roller expanded into the tube sheets providing a leakproof seal. The tube material will be copper. Intermediate steel tube supports should be provided at intervals not exceeding 1200 mm.

b. Evaporator (Chiller)

Chiller shall be provided with eliminator to prevent liquid carry over to the compressor. The chiller shall be provided with liquid level sight glass and a relief valve or rapture disc of the bursting type to prevent excess pressure in the heat exchanger. The chiller shall be horizontal, shell and tube type, provided with the following connections and accessories, as separately identified in the Schedule of Quantities:

i. Refrigerant inlet and outlet pressure gages.

ii. Water inlet and outlet connections.

iii. Drain and vent connections with stop valves.
iv. Pressure gauges on water inlet and outlet connections.
v. Descaling valves.

Chiller shall be factory insulated with 19 mm thick nitrile rubber/or equivalent thermal insulation as per manufacturers standard with vapor barrier, thermal insulation material. The insulation shall be applied in such a manner that water boxes and covers shall be removable without damaging it.

c. Condenser

The condenser shall be horizontal, shell and tube type. The condenser shall be complete with the following accessories, as separately defined in the Schedule of Quantities:

i. Refrigerant inlet and outlet pressure gages.

ii. Water inlet and outlet connections.

iii. Drain and vent connections with stop valves.

iv. Pressure gauges on water inlet and outlet connections.

v. Descaling valves.

2.10 INSTALLATION

The chilling machine shall be installed over a cement concrete platform and shall be adequately isolated as per manufacturers recommendations against transmission of vibrations to the building structure. For open type, special attention shall be paid to the alignment of the drive and driven shafts; final alignment shall be checked at site in presence of the Owner’s site representative, using a dial indicator. Compressor and motor sole plates, anchor bolts and sleeves and necessary vibration isolation pads shall be included.
2.11 PAINTING

Screw water chilling machine shall be finished with durable enamel paint. Shop coats of paint that have become marred during shipment or erection, shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

2.13 PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. Capacity ratings, and power consumption with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation. Capacity shall be ascertained by measurements of chilled water flow rate and temperature of chilled water in and out of the chilling unit. Power consumption shall be computed from measurements of incoming voltage & input current to the chilling machine.

2.14 WATER CONDITIONING EQUIPMENT FOR WATER COOLED SCREW CHILLERS

(Tube Cleaning System)

Water conditioning equipment shall be non-intrusive type which can be mounted on the periphery of the common condenser header and should help in Dissolves and removes existing lime-scale, Prevent new lime-scale accumulation, Enhances filtration efficiency, treats bacteria and algae & Inhibits corrosion

The water conditioning equipment shall induce a decaying sine oscillation of ±150 kHz into the water system, essentially making the water in the pipe a part of an electric circuit. The process with charge Hard water which draws the bicarbonate negative (-) ions and calcium positive (+) ions together. The ions should form a microscopic cluster within micro-seconds. The cluster should be stable as long as the signal is present and shall be removed from the system at cooling tower level.

The signal should have the capability to travel at least 2,000 rmt pipeline.

The signal should be capable to travel in the pipe of any material of construction ie. PVC, MS, SS.

It should help to maintain the following parameters under control:
1. Condenser approach should be maintained less than 5 Deg F and monitored which will help in direct savings in power at chiller.

2. Stop use of anti-scalant, softener, chemicals etc. Biocide level should be reduced by 75% of the standard to take care of areas where the water has low or no flow.

3. This equipment shall remove legionella, e-coli, Klebsiella, pseudomonas.

   The equipment should be with CE Marking & ISO Certification.

3. **PUMPS**

   3.1 **SCOPE**

   The scope of this section comprises the supply, erection, testing and commissioning of water pumps conforming to these Specifications and in accordance with requirements of Schedule of Quantities.

   3.2 **TYPE**

   The type and size of all chilled water, condensing water, cold water and condensate drain pumps for air conditioning applications shall be in accordance with requirement of Drawings and Schedule of Quantities.

   3.3 **CAPACITY**

   Water flow rates and head of the pumps shall be in accordance with the requirements of Schedule of Quantities.

   3.4 **SPLIT CASING PUMPS**

   a. Pump casing shall be close-grained cast iron of heavy section, horizontally/vertically split, making possible complete servicing of rotating parts without breaking piping or motor connections. Motor to pump connection shall be of the flexible coupling type. Suction passages shall be volute in form, promoting smooth entry to impeller and increased efficiency. Impeller shall be bronze or gun metal, double suction, enclosed type, hydraulically balanced and passages smooth-finished for minimum friction and maximum efficiency. Impeller rings shall be secured from relative movement by tongue and groove fittings. Shaft shall be steel, protected by gunmetal sleeves extending through stuffing boxes. Stuffing boxes shall be extra deep, water sealed with renewable bushes. Shaft shall be supported in ball /journal bearings, grease lubricated, contained in easily removable housing. Pumps shall be fitted with mechanical seals, an air valve, two grease lubricators, drain plug and water seal drain connections.
b. Motor shall be energy efficient, totally enclosed, fan-cooled, class-F insulation. Motor shall be specially designed for quiet operation and its speed shall not exceed 1440 rpm. The motor rating shall be such as to ensure non overloading of the motor throughout its capacity range. Motor shall be suitable for 415±10% volts, 3 phase, 50 cycles AC, power supply with efficiency as per IS - 12615.

c. Base shall be of a size suitable for the pump, motor and shaft and shall be constructed of cast iron or welded steel. Flexible coupling shall be protected by a guard mounted on the common base.

d. Installation : The pump shall be installed on a concrete foundation with vibration isolators as per Approved-for-Construction shop drawings/Schedule of Quantities.

3.5 MONOBLOC PUMPS

a. Pump shall be monobloc end-suction design directly connected to motor. The pump casing shall be of cast iron. Impeller shall be cast iron, hydraulically balanced and keyed to shaft. Stuffing boxes shall be integral with casing and water sealed. Shaft sleeve shall be of gun metal extending through stuffing boxes.

b. Motor shall be drip and splash proof, designed as integral part of pump. Motor shall be suitable for 415±10% volts, 3 phase, 50 cycles AC power supply & energy efficient as per IS - 12615.

c. Installation : The pump base shall be mounted on a concrete foundation as per on Approved-for-Construction shop drawings.
3.6 LUBRICATION

Upon installation of the complete system and before testing, the pump shall be lubricated in strict accordance with the manufacturer’s instructions.

3.7 PUMP ALIGNMENT

Split casing pumps, prior to testing, shall be aligned with a dial indicator within 0.05 mm.

3.8 PAINTING

All pumps, motors and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

3.9 PERFORMANCE DATA

Pump performance curves and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

3.10 TESTING

Pump performance shall be computed from the pump curves provided by manufacturer. All pumps shall be tested at factory as per relevant BIS codes.
4. VARIABLE SPEED PUMPING SYSTEM

4.1 SCOPE

The scope of this section comprise the supply, erection, testing and commissioning of variable speed pumping package consisting of following:

a. Individual Components
b. Pump Control Panel
c. Adjustable Frequency Drive
d. Different pressure transmitted
e. Logic Programming for sequence of Operation
f. Power wiring and control wiring shall be carried out by installation contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

4.2 REFERENCES

a. ANSI - American National Standards Institute
b. NEMA - National Electrical Manufacturers Association
c. UL - Underwriters Laboratories Inc.
d. ETL - Electrical Testing Laboratories
e. CSA - Canadian Standards Association
f. NEC - National Electrical Code
g. ISO - International Standards Organization
h. IEC - International Electrochemical Commission

4.3 SUBMITTALS

Submittals shall include the following and shall be specific to this project. General Submittals shall not be accepted.

b. Sequence of operation
c. Shop drawing indicating dimensions, required clearances and location and size of each field connection.

d. Power and control wiring diagrams.

e. System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and Adjustable Frequency Drive (AFD) efficiencies, job specific load profile, staging points, horse power and kilowatt/hour consumption.

f. Pump data sheets.
4.4 **QUALITY ASSURANCE**

a. The pumping package shall be assembled by the pump manufacturer. An assembler of pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump manufacturer. The manufacturer shall assume “Unit Responsibility” for the complete pumping package. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.

b. The local supplier of Chilled Water Variable Speed Pumping System (VSPS) shall have relevant expertise in all aspects of design, application engineering, installation, programming, interfacing, commissioning and after sales service.

c. All functions of the variable speed pump control system shall be tested at the factory prior to shipment. This test shall be conducted with motors connected to AFD output and it shall test all inputs, outputs and program execution specific to this application.

d. Tenderer shall comply with all sections of this specification relating to packaged pumping systems. Any deviations from this specifications shall be clearly defined in writing at time of bid. If no exceptions are taken at time of bid, the supplier shall be bound by these specifications.

4.5 **MANUFACTURED UNITS**

a. Furnish and install as shown on the plans a Variable Speed Pumping System as per approved manufacturers.

b. The control system shall include as, a minimum, the programmable logic pump controller, adjustable frequency drive(s) and remote sensor / transmitters as indicated in the drawings and schedule of quantities on the plans. Additional items shall be included as specified or as required to properly execute the sequence of operation.

c. The variable speed pump logic controller, adjustable frequency drives, AFD bypass if indicated in schedule of quantities, and remote sensor / transmitters shall be shipped as individual components to the job site.

d. Pump logic controller, adjustable frequency drives, sensor / transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

e. Power wiring shall be installed by the mechanical contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

f. Low voltage wiring shall be installed by the mechanical controls contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.
4.6 **PUMP LOGIC CONTROLLER**

a. The pump logic controller assembly shall be listed by and bear the label of Underwriter’s Laboratory INC. (UL). The controller shall meet Part 15 of FCC regulations pertaining to class A computing devices. The controller shall specifically designed for variable speed pumping applications.

b. The controller shall function to a proven program that safeguards against hydraulic conditions including :

i. Pump flow surges
ii. Hunting
iii. End of curve
iv. System over pressure.
v. NPSHR above NPSHA
vi. Motor overload
c. The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitter as indicated on the plans. It will then select the analogue signal that has deviated the greatest amount from its setpoint. This selected signal shall be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling upto three pumps in parallel.

d. The pump logic controller shall have an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.

e. The hydraulic stabilization program shall utilize a proportional-integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.

f. The pump logic controller shall be self prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:
   
i. Multi-fault memory and recall last 10 faults and related operational data
   ii. Red fault light, Yellow warning light and Green power on light.
   iii. Soft-touch membrane keypad switches.

g. The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.

h. Controller shall be capable performing the following pressure booster function:
   
i. Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.
   ii. High system pressure cut-out to protect the piping system against high pressure conditions.
   iii. No flow shut down to turn the pumps off automatically when system demand is low enough to be supplied by hydropneumatic tank. No flow shutdown shall require any external flow meters, flow switches, nor pressure switches to determine when a No Flow condition exists.

i. The following communication features shall be provided to BAS:
   
i. Remote system start / stop non-powered digital input.
   ii. Failure of any system component. Output closes to indicate alarm condition.
   iii. One 4-20 mA output with selectable output of:

   - Frequency
• Process Variable
• Output Current
• Output power.

j. The following communication features shall be provided to the building automation system via an RS-485 port utilizing Johnson Controls Metasys N2 protocol or equivalent protocol.

i. Individual Analog Input
ii. Individual Zone Set Points.
iii. Individual Pump / AFD on/off status.
iv. System percent speed.
v. System Start / Stop command
vi. System operation mode.
vii. Individual KW signals.
viii. System flow, when optional flow sensor is provided.

k. The pump logic controller shall be a ITT industries technologic 500 or approved equal housed in a NEMA 1 Enclosure.
4.7 ADJUSTABLE FREQUENCY DRIVE

a. The adjustable frequency drives shall be Pulse Width Modulation (PWM) type, microprocessor controlled design.

b. The Adjustable Frequency Drive (AFD), including all factory installed option, be tested to UL standard 508. The AFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.

c. The AFD shall be housed in a NEMA 1 enclosure. AFF with plastic enclosure shall not be acceptable.

d. The AFD shall employ and advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and lift. Power factor shall be near unity regardless of speed or load.

e. The AFD shall have balanced DC link reactors to minimize power line harmonics AFDs without a DC link reactor shall provide a 3% impedance line reactor. VFD’s shall have built-in Active harmonic filters. THDI & THDV not to expect 5% at source for VFD.

f. Input and output power circuit switching can be done without interlocks or damage to the AFD.

g. The following customer modifiable adjustments shall be provided:
   i. Accel time.
   ii. Decel time.
   iii. Minimum Frequency.
   iv. Maximum Frequency.

h. RS-485 communication for Johnson Controls N2 shall be available and provided as an option.

i. An automatic energy optimization selection feature shall be provided. This feature shall reduce voltage when lightly loaded and provide a 3% to 10% additional energy savings.

j. The AFD shall be suitable for upto 3300 feet elevation above sea level without derating. Maximum operating ambient temperature shall not less than 104 degrees F. AFD shall be suitable for operation in environments upto to 955 non-condensing humidity.

k. The AFD shall be capable of displaying the following information in plain English via an alphanumeric display:
   i. Frequency.
   ii. Voltage.
   iii. Current.
   iv. Kilowatts per hour.
v. Fault Identification.
vi. Percent Torque.
vi. Percent Power
viii. RPM

4.8 AUTOMATIC AFD BYPASS

a. Variable speed pumping system shall be equipped with an automatic bypass in accordance with requirement of Schedule of Quantities.

b. Bypass shall consist of a main power disconnect with ground fault protection, a pair of interlocked contractors and a motor overload relay. All are to be mounted in a NEMA 1 enclosure.

c. Automatic bypass shall operate as shown in schematic drawings described in the sequence of operation.
4.9 SENSOR / TRANSMITTERS

a. Provide field mounted differential pressure sensor transmitters as indicated in BOQ or on the plans. Unit shall transmit an isolated 4-20mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have a corrosion resistant steel body with 1/8” NPT process connection. It shall have a NEMA 1 electrical enclosure capable of withstanding 450 PSI static pressure. Accuracy shall be within 0.5% of full span. The installation contractor shall ensure that these differential pressure sensor are enclosed within pilfer proof housing such MS plate housing with lockable access panel.

4.10 SECONDARY PUMPS

a. SCOPE

The scope of this section comprise the supply, erection, testing and commissioning of water pumps conforming to these specifications and in accordance with requirements of Schedule of Quantities.

b. TYPE

The type and size of secondary chilled/hot water, and pumps for air conditioning applications shall be in accordance with requirement of Drawings and Schedule of Quantities.

c. CAPACITY

Water flow rates and head of the pumps shall be in accordance with the requirements of Schedule of Quantities.

d. SPLIT CASING PUMPS

i. Pump casing shall be close-grained cast iron of heavy section, horizontally/vertically split, making possible complete servicing of rotating parts without breaking piping or motor connections. Motor to pump connection shall be of the flexible coupling type. Suction passages shall be volute in form, promoting smooth entry to impeller and increased efficiency. Impeller shall be bronze or gun metal, double suction, enclosed type, hydraulically balanced and passages smooth-finished for minimum friction and maximum efficiency. Impeller rings shall be secured from relative movement by tongue and groove fittings. Shaft shall be steel, protected by gunmetal sleeves extending through stuffing boxes. Stuffing boxes shall be extra deep, water sealed with renewable bushes. Shaft shall be supported in ball /journal bearings, grease lubricated, contained in easily removable housing. Pumps shall be fitted with mechanical seals, an air valve, two grease lubricators, drain plug and water seal connections.
ii. Motor shall be energy efficient, totally enclosed, fan-cooled, class-F insulation and suitable for operation on Adjustable Frequency Drive (AFD). Motor shall be specially designed for quiet operation and its speed shall not exceed 1440 rpm. The motor rating shall be such as to ensure non overloading of the motor throughout its capacity range. Motor shall be suitable for 415 ± 10% volts, 3 phase, 50 cycles AC, power supply.

iii. Base shall be of a size suitable for the pump, motor and shaft and shall be constructed of cast iron or welded steel. Flexible coupling shall be protected by a guard mounted on the common base.

iv. Installation: The pump shall be installed on a concrete foundation as shown in Approved-for-Construction shop drawings.

v. Each pumps shall be provided with certified performance curves showing power absorbed and corresponding flow rates by varying the speed. Tests shall be done at factory and may be witnessed by department site representative.
e. PUMP ALIGNMENT

Split casing pumps, prior to testing shall be aligned with a dial indicator within 0.05 mm. Monobloc pumps shall be factory aligned with motor on common base, and need not be realigned at site.

f. PERFORMANCE DATA

Pump performance curves and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

6.6 g. TESTING

Pump performance at site shall be computed from the pump curves provided by manufacturer.

4.11 PAINTING

All variable pumping system, pumps, motors and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

4.12 SEQUENCE OF OPERATION

a. The system shall consist of a pump logic controller, multiple pump / AFD sets, with manual and automatic alternation and pump staging.

b. The pumping system shall start upon the closure of customer’s contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.

c. When the pump logic controller selector switch is in the LOCAL position, and start command on Tech 500 is given via operator interface, the pumping system shall operate automatically.

d. Sensor / transmitters shall be provided as indicated on the plans.
e. Each sensor / transmitter shall send a 4-20 mA signal to the pump logic controller, indicative of process variable condition.

f. The pump logic controller shall compare each signal to the independent, engineer / user determined set points.

g. When all set points are satisfied by the process variable, the pump speed shall remain Constant at the optimum energy consumption level.

h. The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

i. If the set point can not be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump.

j. The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.

k. Further change in process variable shall cause the pumps to change speed together.

l. When the set point criteria can be safely satisfied with fewer pumps, the Technologic pump logic controller shall initiate a timed destage sequence and continue variable speed operation.

m. As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump / motor.
n. In the event of a AFD fault, the pump logic controller automatically initiates a times sequence of events to start the redundant pump / AFD set in the variable speed mode. The redundant variable speed system shall be started through the pump logic controller.

o. Upon AFD fault(s), the pump controller shall display an alarm condition through a plain english message.

p. AFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.

q. In the event of the failure of a zone sensor / transmitter, its process variable signal shall be removed from the scan / compare program. Alternative zone sensor / transmitters, if available, shall remain in the scan / compare program for control.

r. Upon sensor failure a plain english warning message shall be displayed on the operator interface of the pump logic controller.

s. In the event of failure to receive all zone process variable signals, a user selectable number of AFDs shall maintain a user adjustable speed, reset shall be automatic upon correction of the zone failure.
5. **EVAPORATIVE COOLING UNIT - DOUBLESKIN (AIR WASHER)**:

5.1 **TYPE**:

The evaporative cooling unit shall be double skin construction drawthrough type comprising of various sections such as filter section, humidifier section, supply air fan section, fine filter plenum, factory fabricated (wherever required) as per details given in Drawings and ‘Bill of Quantities’.

5.2 **CAPACITY**:

The cooling capacities, motor HP, static pressure shall be as shown on Drawings and in ‘Bills of Quantities’.

5.3 **HOUSING/CASING**:

The housing/casing of evaporative unit shall be of double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong and self-supporting framework for various sections.

25 mm thick double skin panel shall be made of 0.8 mm plasticized/pre coated PVC sheeted GSS on outside and 0.8 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket fixed in built-in groove of aluminum frame in between to make the joints airtight.

Framework for each section shall be joined together with soft rubber gasket in between to make the joints airtight. Suitable airtight access doors/panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on extruded aluminum channel framework having pressure die cast aluminum joints.

5.4 **DRAIN PAN**:

Drain pans shall be constructed of 18G stainless steel (SS-304 Grade) with necessary both ways slope to facilitate fast removal of drain water.
5.5 **MOTOR DRIVE:**

Fanmotors shall be suitable for 415 (+/-) 10% volts, 50 Hz, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fans shall be provided through belt drive arrangement or directly coupled/driven. Belt shall be of oil resistant type. Motor shall be of efficiency class IE-3.

5.6 **FAN:**

The fan shall be backward curved, double inlet, double width type. The wheels and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings. The fan shall be selected for a noise level less than 65-DB (A) at a distance of 2 m.

The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 9 m/sec. Fan housing with motor shall be mounted on a common extruded aluminum base mounted inside the housing on anti-vibration mounts. The fan outlet shall be connected to casing with the help of double fire retardant fabric acting as a flexible connection for anti-vibration.

5.7 **WET DECK HUMIDIFIER:**

Wet deck humidifier pads shall be of cellulose paper minimum 300 mm deep to provide at least 90% saturation efficiency at 2.5 MPS or less air face velocity. The cellulose paper pads shall be housed in a galvanized steel casing complete with water distribution header and interconnecting heavy duty flexible PVC / GI pipes between pump and distribution header.

5.8 **WATER CIRCULATING PUMPS:**

Water circulating pumps shall be vertical type. The suction portion shall be at the bottom with proper seal arrangement to directly pick up water from the stainless steel drain pan. The pump shall be suitable to operate at 415 (+/-) 10% V, 50 Hz AC supply.

Necessary water bleeding arrangements shall be incorporated with separate drain connection provided in the stainless steel drain pan to bleed small percentage of total circulated
water in order to ensure compulsory water change over during running of the system.

5.9 FILTERS:

Each unit shall be provided with a factory assembled filter section containing washable air filter having bonded expanded aluminum media with aluminum frame. Filter media and frame shall be rust proof and corrosion resistant. Filter face velocity shall not exceed 150 meter per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These shall be held within the frames by sliding the cells between guiding channels.

5.10 FRESH AIR INTAKES:

Anodized extruded aluminum construction (20 microns and above) fresh air intakes louvers with bird screen and extruded aluminum low leakage construction damper shall be provided for FA. Blades shall be made of extruded aluminum. Construction shall be rattle free. Fresh air fans and fresh air intakes shall be as per the requirement of ‘Bills of Quantities’.

5.11 SAFETY FEATURES:

Each evaporative unit must have following safety features:-

- The fan access door shall be equipped with micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

- The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

- All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

5.12 PERFORMANCE DATA:

Evaporative cooling units shall be selected for optimum operating noise level. Fan performance
rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the system.

5.13 TESTING:

Performance of evaporative cooling unit shall be computed from the measurements of air flow and dry and wet bulb temperature of air entering and leaving the unit. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated electronic instrument. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.
6. **KITCHEN EXHAUST SCRUBBER - DRY SCRUBBERS:**

6.1 **SCOPE:**

The scope of this section comprises the supply, erection, testing and commissioning of dry scrubbers comprising of electrostatic sections for use in kitchen exhaust/grease/exhaust air treatment.

6.2 **TYPE:**

The unit shall be CE certified and of the type indicated on Drawings and identified in Bill of Quantities.

6.3 **CAPACITY:**

The air-moving capacity of the unit shall be as shown on Drawings and in Bill of Quantities.

6.4 **TECHNICAL PARAMETERS:**

The unit shall provide efficiency of 90% or better for single pass base on ASHRAE test method at flow rates of 800–1300 CFM per module (supported by sample test report by a US laboratory). Multiple units can be joined together for increased volume. The system shall be suitable to connect to a fan section with an average velocity of 500 FPM across an air cleaner.

6.5 **EQUIPMENT SPECIFICATIONS:**

The unit shall be designed and constructed and supplied by a manufacturer specializing in the research, design, and manufacture of products specified in this section with a minimum of three years of documented experience, and capable of issuing complete catalog data on the total product.

6.6 **UNIT HOUSING:**

Housings shall be 16-gauge zinc-coated steel construction to protect against rust and corrosion. Each
sections shall include single door access, located on one side of the unit. The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. Doors to charged high voltage components shall be equipped with electrical interlocks for interconnection into the primary power supply, to prevent access when the components are energized. The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8” thick gasket shall be installed to prevent leakage. The bottom drain pan under ESP section containing integral washing system shall be pitched downward 1/4” per foot minimum towards a 3” NPT drain nipple.

6.7 **BASE CONSTRUCTION:**

These sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if ordered.

6.8 **FINISH:**

The external casing finish shall be durable industrial grade semi-gloss baked-on epoxy, not less than 3 mil minimum thickness.

6.9 **CELLS WASH MODULE:**

The Cells Wash module shall incorporate a mechanical filtration. The stationary filter from the direction of airflow will be a metal mesh filter with single, gasketed access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

6.10 **ELECTROSTATIC PRECIPITATOR MODULE:**

The electronic air cleaner shall be the two-stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate (supported by sample test report by a US laboratory). The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.
6.11 **IONIZING COLLECTION CELL:**

Ionizing-Collecting cell(s) shall be of one-piece construction 14.23" inches deep in direction of airflow. All support framing, endplates and ionizer ground electrode shall be 0.090 inch thick aluminum. Both repelling and collector plates shall be 0.020 inch thick aluminum, 9.125 inches deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods. Spacing between plates shall be no less than 0.175 inch. Ionizing electrode shall be 24 gauged stainless steel spiked design, ionization wires are not acceptable, rigidly supported both vertically and laterally. High voltage support insulatorsshall be of self-glazing Cordierite ceramic with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking. Insulatorsshall be mounted out of the airstream, to reduce contaminant buildup. All high voltage electrical connections within each tier of cells shall be between cells and automatically made when cells are installed. All electrical connections between unit tiers and high voltage connections between power packs and cells shall be located on the access doorend of the cabinet and manually connected for ease of service.

6.12 **POWERSUPPLIES:**

Powersupplies shall be 100% solid state, UL Listed. Operate on 200 to 240 VAC, 50 Hz. 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. A regulated output of up to 5.5 MA shall be supplied to maintain the specified collection efficiency. Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The powersupply shall operate over a temperature range of -32 degrees F to 140 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output leads shall be sealed and a bleeder resistor incorporated to restore electrical charge where the powersupply(s) are de-energized. Module of capacity above 3000 CFM shall be equipped with Pulse width Modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of low/high voltage from the source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more than 50 watts per ESP cell.

All powersupply components shall be designed for ease of mounting and servicing. High voltage power cables shall be of one continuous length, splicing is not acceptable.

6.13 **SYSTEM CONTROLS:**

Programmable Logic Controller (PLC) shall be housed in an NEMA-12 type enclosure. Controllers shall be shipped for remote mounting and must be installed indoors or other means of weather protection provided if installed. Terminal shall be provided to interconnect the system fan and shall sequence the detergent wash, soak, rinse, fan forced dry and return to operation cycle. All sequencetimes shall
befaultoryset. Controlinitiationshallbesemiautomatic,pushbuttoninitiated, orfullyautomaticby
timeclock, with semiautomaticpush buttonoverride.

Aremote mountedSleep ModeResetSwitch(momentarycontactpushbutton type)shallbesupplied
tobeinginstalledatthekitchenhoodlocationtoenergizetheaircleaningsystemafterthewash
systemhascompleted.Theswitch mayoptionally beinstalled onthe panelofthe ATScontrol
enclosure.

6.14 AUTOMATIC TIMECLOCK:

Thecontrolcabinetshall befurnishedwithafactoryinstalledandwired7-dayinitiatorclockwith
batterybackup.

6.15 WATERWASH/DETERGENTSYSTEM:

Detergentwash andrinsewillbeaccomplishedwithmanifolds located ontheair enteringsides of the
(prefilterwashcollarissupplied) ionizing/collection cell tier through the spraynozzles delivering acn
shaped pattern. The detergent reservoir, pump, motor and bypass valves shall be provided as
prepackaged assembly with an adjustable detergent volumesetting. The detergent pump motor shall
be 0.75kWTEFV motor, 220v/50hz/1ph, with pump of positive displacement self-priming and deliver
not less than 6 GPM at 50 PSI minimum outlet pressure. Pump motor shall contain built-in overload
protection. Main waterline, strainer and solenoid valves are factory furnished with the system.
Detergentsystemshalla 30-gallon tank for remotemounting within initial supply of biodegradable
detergent as per unit manufacturer’s recommendations.

6.16 STATIC PRESSURE DROPS:

The pressuredropshall not exceed the following(inches H2O):

ESPSection0.14” MetalMesh pre-filter or afterfilter0.10”. The ESP section must have both an
internal pre-filter and an afterfilter, select and add foreach.
External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc. must be added with the above internal equipment losses to calculate total fan static pressure required.

6.17 **ADSORBER MODULE:**

The Absorber Module shall be designed to utilize required number of 23.38” x 23.38” x 2” deep trays that are powder painted for corrosion resistance, may be reused and are secured in a V-bank arrangement on steel slide tracks. Trays shall be charged with 18.25 lbs. of activated carbon granules.
7. **INLINE & PROPELLER FANS – SPECIFICATIONS:**

7.1 **SCOPE:**

The scope of this section comprises the supply, installation, testing and commissioning of centrifugal and inline fans conforming to these specifications and in accordance with the requirement of drawings and ‘Billsof Quantities’.

7.2 **TYPE:**

Centrifugal and inline fans shall be of type as indicated in drawings and ‘Billsof Quantities’.

7.3 **INLINE FANS:**

Inline fans shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. The fan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan materials shall be galvanized sheet steel. The casing shall be constructed of 14G sheet steel. The fan casing, motor mount & straightening vanes shall be of welded steel construction. The motor mounting plates shall be of minimum 20mm thick & machined to receive motor flange. Casings shall be provided with 2 nos. wide hinged doors which open easily. Inspection doors with handles & neoprene gaskets shall also be provided. Casing shall have flanged connections on both ends for ducted applications. Support brackets for ceiling suspensions shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential & minimizing turbulence. Casing shall be primed & finished with enamelpaint. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions & high energy efficient type, min. Eff-1/IE-2. It shall be suitable for 415/220+/-10% volts, 50 cycles, 3/1phase powersupply, provided with class “B” insulation. Motors shall be especially designed for quiet operation & motor speed shall not exceed 1500 RPM. Formaximum efficiency, minimum horse power, Outlet cone for static pressure regain, inlet cone & fansilencers, ifreqd. shall be provided with all fans. Fans shall be factory assembled & shipped with all accessories factory mounted.

All single-phase fans shall be provided with speed regulators while all three phase fans shall be provided with opposed bladedampers in GSS construction at fan outlet for air balancing.

7.4 **PROPELLER FANS:**

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Propeller fans shall be direct driven, three or four blade type mounted on steel mounting plate with orificering.

Mounting plates shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plates shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orificering shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the airstream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced.

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fanspeed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycle 3-phase power supply and for smaller fans shall be suitable for 220±6% volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and Bill of Quantities.

Motor shall be of high energy efficient type, min. Eff-1/IE-2.

Propeller fans shall be provided with following accessories:

i. Wireguard and bird-screen
ii. Gravity louvers at outlet
iii. Regulator for controlling fanspeed for single-phase fan motor.
v. Wiring between regulator and fan motor including termination at both ends.

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7.5 PERFORMANCE DATA:

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

7.6 TESTING:

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and incoming current.

All fans shall be subjected to inspection and testing requirements as given below. The contactor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of CLIENT maybe tested at the factory in his presence.

The performance of the Fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves.

i. Airflow capacity

ii. Static head developed

iii. BHP requirement

iv. Vibration and noise level
8. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS (NEMA STANDARDS):

8.1 GENERAL REQUIREMENTS:

i. This specification covers complete variable frequency drives (VFDs) designated on the drawing schedule to be variable-speed. All standard and optional features shall be included within the VFD.

ii. The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.

iii. The VFD shall be factory mounted and tested as a single unit under full load before dispatch.

iv. The VFD shall be tested to NEMA Standards. The appropriate UL label shall be applied.

v. The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

vi. The VFD shall be NEMA certified before a short circuit current rating of 100kA and labeled with its rating.

8.2 TECHNICAL REQUIREMENTS:

i. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

ii. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor’s service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

iii. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental
(displacement) power factor near unity regardless of speed or load.

iv. The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

v. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

vi. IEEE 519, 1992 recommendations shall be used for the basis of calculation of total active harmonic distortion (THD) at the point of common coupling (PCC). On request, VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc. to allow this calculation to be made.

vii. All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3:2004, Category C1 with 50 mmotor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.

viii. The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 seconds while starting.

ix. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

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x. A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor’s speed and load to adjust the applied voltage to maximize energy savings.

xi. The VFD must be able to produce full torque at low speed to operate direct driven fans.

xii. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

xiii. An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to perform the test.

xiv. Galvanic isolation shall be provided between the VFD’s power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

xv. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

xvi. The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allowable use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

8.3 PROTECTIVE FEATURES:

i. Overload protection in VFD shall automatically compensate for changes in motor speed.
ii. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

iii. Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to program and output trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

iv. Protect from undervoltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

v. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

vi. If the temperature of the VFD's heatsink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heatsink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

vii. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

viii. The VFD shall have a temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

ix. Protect from output switching: The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans/pumps near the motor with VFD in ON mode.

x. The VFD shall store in memory the last 10 alarms. A description of the alarm and the date and time of the alarm shall be recorded.
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xi. When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

8.4 INTERFACE FEATURES:

i. Autokeys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

ii. There shall be an “Info” key on the keypad. The Info key shall include “on-line” context sensitive assistance for programming and troubleshooting.

iii. The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Manual or Automatic mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

iv. A password-protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

v. All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

vi. To setup multiple VFDs, it shall be possible to upload all setup parameters to the VFD’s keypad, place the keypad on all other VFDs, and download the setup parameter to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only. Keypad shall provide visual indication of copy status.

vii. Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.
viii. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

ix. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

x. A three-feedback PID controller to control the speed of the VFD shall be standard.

xi. This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signal to a common setpoint, to individual setpoints and to automatically select either the maximum or minimum deviation signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

xii. The VFD shall be able to apply individual scaling to each feedback signal.

xiii. For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

xiv. The VFD’s PID controllers shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for pressure feedback sensors which is located near the output of the pump rather than out in the controlled system.

xv. The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

xvi. Floating point control interfaces shall be provided to increase/decrease speed in response to contact closures.

xvii. Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.
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xviii. ProgrammableSleepModeshallbeabletostoptheVFD. Whenitsoutputfrequency dropsbelowaset “sleep”levelforaspecifiedtime, whenanexternalcontactcommandsthat theVFDgoesintosleepMode, orwhentheVFDdetectsanoflowsituation, theVFDmay be programmedtostop. WhentheVFD’sspeediscontrolledbyits PIDcontroller, itshall be possible to program a “wake-up”feedback valuethatwill causetheVFD to start. Toavoid excessivestartingandstoppingofthedrivenequipment, itshall be possible to program a minimumruntimebeforethesleepmodecanbeinitiated andaminimumsleep timeforthefVD.

xix. Arunpermissivecircuitshallbeprovidedtoaccepta“systemready”signaltoensurethat theVFDdoesnothostartuntildampersor otherauxiliaryequipment areintheproperstatefor VFD operation. Therun permissivecircuitshallalsobe capable ofinitiating an output “run request” signaltoindicate the externalequipment that the VFD hasreceived a requestto run.

xx. VFDshallbe programmable to display feedback signals in appropriate units, such as inches of watercolumn (in-wg), pressurepersquareinch (psi) or temperature (°F). Examplescan be roomtemperature in °C, returnair temperature in °C, supplyair temperature in °C, CO₂ concentrationin ppm, pressure in bar, differential pressure in PSI etc.

xxi. VFDshallbe programmable to sense the lossofload. The VFDshallbe programmable to signal thiscondition viaakeypadwarning, relay outputand/or over theserial communicationsbus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timertokeep brief periods of no load from falsely triggering this indication.

8.5 STANDARD CONTROL AND MONITORING INPUTS AND OUTPUTS:

i. Four dedicated, programmable digital inputsshall be provided for interfacing with the systems control and safety interlockcircuitry.

ii. Twotermsinalsshallbe programmable to act as either digital outputs or additional digital inputs.

iii. Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

iv. Each relay shall have an adjustable on delay/off delay time.

v. Twoprogrammable analog inputsshall be provided that can be either direct-or-reverse acting.
vi. Each shall be independently selectable to be used with either an analog voltage or current signal.

vii. The maximum and minimum range of each shall be able to be independently scalable from 0 to 10V dc and 0 to 20mA.

viii. A programmable low-pass filter for either or both of the analog input must be included to compensate for noise.

ix. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.

x. One programmable analog current output (0/4 to 20mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

xi. It shall be possible to read the status of all analog and digital inputsof the VFD through serial bus communications.

xii. It shall be possible to command all digital and analog output through the serial communication bus.

8.6 OPTIONAL CONTROL AND MONITORING INPUTS AND OUTPUTS:

i. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

ii. These modules shall use rigid connectors to plug into the VFD’s control card.

iii. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

iv. Modules may include such items as:

v. Additional digital outputs, including relay outputs

vi. Additional digital inputs

vii. Additional analog outputs

viii. Additional analog inputs, including Ni or Pt temperaturesensor inputs

ix. It shall be possible through serial bus communication to control the status of all optional analog and digital outputs of the VFD.

8.7 Standard programmable firefighter’s override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will
ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter’s overriding mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

8.8 REALTIME CLOCK:

A real-time clock shall be an integral part of the VFD.

i. It shall be possible to use this to display the current date and time on the VFD’s display.

ii. Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter set points and output relays. It shall be possible to program unique events that occur only during normal workdays, others that occur only on non-workdays, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

iii. All VFD faults shall be timestamped to aid troubleshooting.

iv. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

v. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

vi. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

vii. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

viii. Comparators for comparing VFD analog values to programmed trigger values

ix. Logic operators to combine up to three logical expressions using Boolean algebra.

Delay timers
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xi. A 20-stepprogrammablestructure

xii. TheVFDshallincludeaCascadeControllerwhichallowstheVFDtooperateinclosedloopset
point(PID)controlmodefornemotoratalcontrolledspeedandcontrolthe operation of 3
additional constantspeedmotorstarters.

8.9  **COMMUNICATIONS:**

tothefollowingserialcommunicationprotocolsatnoadditionalcostandwithoutaneedto
install any additional hardwareor software in the VFD:

a. Metasys N2
b. Modbus RTU
c. LAN

VFDshallhavestandardUSBportfordirectconnectionofPersonalComputer(PC)totheVFD.
The manufacturershallprovide atno-charge-PCsoftwaretoallowcompletesetupandaccess
oftheVFDandlogsoVFDonlineoperationthroughtheUSBport.Itshallbepossibletocommunicate
totheVFDthroughthisUSBportwithoutinterruptingVFDCommunicationsotothebuilding
managementsystem.
TheVFDshallhaveprovisionsforanoptional24VDCback-uppowerinterfacetopowerthe
VFD’s control card. This is to allow the VFD to continue to communicate to the building
automationsystemeven ifpower to the VFD is lost.

8.10  **ADJUSTMENTS:**

incrementstoallowtheusertoselectthedesiredoperatingcharacteristics. TheVFDshallalso
be programmabletoautomaticallyreduceitscarrierfrequencytoavoidtrippingduetothermal
loading.
Four independent setups shall be provided.
Four presetspeeds persetupshall be provided for a total of 16.
Eachsetupshallhavetwoprogrammablerampupandrampdowntimes.Acceleration and
decelerationramptimesshallbeadjustableovertherangefrom1to3,600seconds.
Eachsetupshallbe programmable for a uniquecurrentlimitvalue. If the outputcurrentfrom
theVFDreachesitsvalue, anyfurtheratemptoincreasethecurrentproducedbytheVFD
willcausetheVFDto reduce its outputfrequency to reduce the load on the VFD. If desired, it
shallbe possible to programatimer which will cause the VFD to trip after a programmed
time period.
If the VFD trips on one of the following conditions, the VFD shall be programmable for
automatichandmanual reset: external interlock, under-voltage, over-voltage, current limit, over
temperature, and VFD overload. Thenumber of restart attempts shall beselectablefrom 0 through 20
or infinitely and the time between attemptshallbe adjustable from 0 through 600 seconds.
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An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating at load speeds that cause vibration in the drive equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

8.11 OPTIONAL FEATURES:

All optional features shall be built and mounted by the VFD manufacturer as an in-built factory solution. All optional features shall be NEMA by the VFD manufacturer as a complete assembly and carry a NEMA.

8.12 SERVICE CONDITIONS:

Ambient temperature at full speed, full load operation with continuous-rated output current:

a. -10 to 45°C for ratings up to 90 kW without derating

b. -10 to 40°C for ratings 110 kW and higher without derating

c. Relative Humidity: 0 to 95%, non-condensing.

d. Elevation: Upto 3,300 feet without derating.

e. AC line voltage variation: +10% of nominal with full output.

f. VFD Enclosure protection: IP 55, integral, with no additional cabinets.

g. Side Clearances: No side clearances shall be required for cooling.

h. All power and control wirings shall be done from the bottom.

i. All VFDs shall be plenum rated.

8.13 QUALITY ASSURANCE:

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i. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

ii. All optional features shall be functionally tested at the factory for proper operation.
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11  9.  AIR HANDLING UNITS

9.1  SCOPE

The scope of this section, comprises the supply, erection, testing and commissioning of double skin construction air handling units, conforming to these Specifications and in accordance with requirements of drawings and of the Schedule of Quantities.

9.2  TYPE

The air handling units shall be double skin construction, draw-thru type comprising of various sections, filter section, coil section and fan section, mixing box, (wherever the return air and fresh air are ducted) as shown on drawings and included in schedule of quantities.

9.3  CAPACITY

The air handling capacities, maximum motor horse power and static pressure shall be as shown on Drawings and in Schedule of Quantities.

9.4  CASING

Double skinned panels shall be 23 / 46 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 kg/m³) with K factor not exceeding 0.02 Watt/Mc shall be fixed to 1.5 mm thick aluminum alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticised sheet of 0.63 mm thick, and inner sheet of 24 Gauge plain G.I.Sheet.

The entire framework shall be mounted on an aluminum alloy or galvanized steel (depending on size) channel base as per manufacturer’s recommendation. The panels shall be sealed to the framework by heavy duty gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminum / hard nylon with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on-site assembly with continuous foam gasket. All fixing and gaskets shall be concealed.

Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be...
Condensate drain pan shall be fabricated from 18 gage stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel with 19 mm elastomeric nitrile rubber.

Internal panels shall be fabricated so that there are no gaps between the panel and frame work. Fabrication clearances shall be closed with blank-off pieces or with sealant. Partitions shall be of sufficient thickness to prevent deflection and vibration during AHU operation. Manufacturer shall provide suitable stiffening by means of box type members across the same. AHU shall be with clean inside surfaces with beveled corners to the best possible extent without crevices as may allow growth of algae / fungus. In case on internal fittings such as dampers, the same shall be with beveled edges and without sharp corners to prevent operator injury. There shall be no screws projecting into AHU or air stream. If the same is unavoidable, the tips shall be fitted with rubber caps to prevent operator injury.

AHU panels shall be factory fitted with pressure ports for DPT installation. The number and size of these shall be confirmed in the AHU technical approval stage. In case opening is to be made in AHU panel, the same shall be with C-channel all around to prevent entry of PUF into air stream. The channels shall be cut at 45 degrees at the corners to avoid overlap. Material for the channel shall be same as that of internal skin of AHU.

Rubber grommets shall be provided at all entry points into AHU such as coil connection, cable entry etc. The same shall be double lip tight fitting to prevent air leakage.

All access doors shall be outward opening. For doors provided downstream of the fan, especially in high static AHUs, additional clamps shall be provided along periphery of door to maintain constant pressure and ensure proper sealing.

9.5 MIXING BOX

AHU’s requiring mixing boxes as specified in Schedule of Quantities shall be complete with fresh and return air dampers.

11.4

9.6 THERMAL BREAK PROFILE

AHU’s such as TFA units, AHU with mixing box having return air ducted shall be provided with thermal break profile as indicated in schedule of quantities. Also these AHU’s shall be provided with 46 mm thick panel. Panels and thermal break profiles for all AHUs shall be designed and assembled in such a way that there shall not be any condensation on AHU with conditions of 35°C and 92% RH (AHU surrounding conditions) at designed operating conditions inside the AHU.
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9.7 DAMPER

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminium sections with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, turning in teflon bushes. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorised operation. Damper frames shall be sectionalised to minimise blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

9.8 MOTOR AND DRIVE

Fan motors shall be energy efficient (EFF-1) and shall be 415±10% volts, 50 cycles, three phase, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 rpm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. For three stage filtration AHUs, belt drive shall not be used and direct driven plug fans shall be used.

9.9 FAN

Fans shall be centrifugal, forward curved / backward curved / aero foil so as to give maximum efficiency for given duty condition. Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 75% Fan casing shall be made of galvanized steel sheet. Fan wheels shall be made of galvanized steel. Fan shaft shall be grounded C40 carbon steel and supported in self-aligning Plummer block operating less than 75% of first critical speed, grease lubricated bearings. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to G6.3 grade as per relevant ISO/AMCA standard. Computerized fan selection print outs shall be submitted along with the offer.

Motors shall be mounted inside the AHU casing on slide rails for easy belt tensioning, and be totally enclosed, fan cooled, to be class `F' insulation. Motors shall drive heavy duty V-belt, constant pitch, drive selected at maximum motor horsepower.
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Both fan and motors assemblies shall be mounted on a deep section aluminum alloy or galvanized steel (depending on size) base frame.

Combination spring and rubber anti vibration mounts shall be provided for isolating the unit casing. Frame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

11.6 COOLING COILS

Chilled water coils shall have 12.5 to 15 mm dia (O.D) tubes minimum 0.4 mm thick with sine wave aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The coil shall have copper header with chilled water supply & return connections protruding out of AHU casing by minimum 150 mm and fitted with dielectric coupling for connection with MS pipes. Each coil shall be factory-tested at 21 kg per sq. m air pressure under water. Tube shall be hydraulically / mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 4 - 5 fins per cm. Water pressure drop in coil shall not exceed 10 PSIG.

Coils shall be provided with mechanical means to purge air from the coil during commissioning by means of a purge valve or nipple. To prevent splashing, discharge from the same shall be routed to the condensate drain pan by means of flexible PVC tubing of suitable diameter. Purge valve / nipple shall be accessible externally or by removal of blanking panel.

All AHU's shall be provided with minimum 6 Row Cooling Coil. All TFA AHU's shall be provided with minimum 8 row cooling coil. TFA units which receives pre-cooled fresh air can be provided with 6 row deep coil upon verification of coil selection output. Reheat coil may be provided if indicated in Schedule of Quantities. Reheat coil shall be 2 row deep and shall be of same construction as above.

In case AHU has multiple coil stacked one above another, intermediate train of SS 304 (18 gauge) shall be provided so that upper level of coil drains into this train. Copper / SS 304 piping shall be provided from this train upto main bottom tray.

Computerized cooling coil selection output shall be submitted. Coil rating shall be as per ARI-410/2006.

9.11 FILTERS

Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters having anodized aluminum frame. The filter shall
have minimum 90% efficiency down to 10 microns. The media shall be supported with HDP mesh on one side and aluminum mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be fully sealed and constructed from aluminum alloy. For green buildings, AHUs shall also be provided with MERV-13 filters, if the project is opting for credit EQ-6.

9.12 ACCESSORIES

Each air handling unit shall be provided with manual air vent at high point in the cooling coil and drain plug in the bottom of the coil. In addition, the following accessories may be required at air handling units, their detailed specifications are given in individual sections, & quantities separately identified in schedule of Quantities.

a. Insulated butterfly valves, balancing valves, ‘Y’ strainer, union & condensate drain piping with ‘U’ trap upto sump or floor drain in air handling unit room, as described in section “Piping”.

b. Thermometers in the thermometer wells & pressure gauge (with cocks) within gauge ports in chilled water supply and return lines as per the section “Instruments”.

c. Water resistance marine light with power cabling.

d. Minimum 2 Nos nameplates (1 in etched metal and other plastic) mounted onto AHU panel with suitable water-resistant adhesive along with relevant warning stickers on various panels. The nameplate shall give all relevant details including fan model selected, motor KW, Air quantity and total static pressure.

9.13 ISOLATORS

Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushy foot mounting type. Minimum vibration isolation efficiency shall be 90%.

9.14 FRESH AIR INTAKES

Extruded aluminum construction duly anodized (20 microns and above) fresh air louvers with bird screen and dampers shall be provided in the clear openings in masonry walls of the air handling unit rooms having at least one external wall. Louvers, damper, pre-filters, ducts and fresh air fan with speed regulator shall be provided as shown on Drawings and in Schedule of Quantities. Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminum construction and shall be rattle-free. Dampers
shall be similar to those specified in “Air Distribution”. Fresh air fans and fresh air intakes shall be as per the requirements of Schedule of Quantities.

9.15 PAINTING

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

II.8

9.16 PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

9.17 TESTING

Cooling capacity of various air handling unit models be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.
10. **ELECTRONIC AIR FILTRATION SYSTEM**

10.1 **GENERAL**

It is the intent of the specification to incorporate highly efficient electronic air filtration system with low pressure drops into the building AHU system.

All AHU’s shall be fitted with a true electronic air cleaner system (complete with washable pre-filter, charging section and collector section) to be installed before the cooling coils. Other forms of air filtration systems such as charged media filters, dielectric media filters, or ionizers (which do not have second stage collector plates) shall not be acceptable. The electronic air cleaner (EAC) shall be capable of removing particulates as small as 0.01 microns including microscopic haze particles, smoke, dust, mould spores and bacteria.

10.2 **APPROVALS / CODE REQUIREMENTS**

The EAC shall be Underwriter Laboratories (UL) Listed. The EAC shall also be EMC (Electromagnetic compatibility) certified. Full documentation must be submitted to confirm compliance to the above requirements.

Ozone level of EACs provided must be within the acceptable limit of 0.05ppm. Tenderers must also provide a test report to confirm conformance.

10.3 **FACTORY SAFETY TEST REPORT**

The EAC must have factory test report to ensure that it meets the following safety and environmental criteria with reference to ES164468, UL 867 and DA 6.2.1:

Performance Testing
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- Ambient and voltage extremes
- E-field test
- Oscillatory transient test
- Lightning test
- EFT (fast transients) test
- ESD (high voltage transients) test
- EMI susceptibility test
- EMI radiation test

Environmental

- Humidity
- Condensation
- Vibration

All tenderers must submit a design analysis conditional qualification test report to confirm that tests have been conducted based on the above criteria and that the EAC has passed these tests.

10.4 SAFETY PROVISIONS

Each EAC cell shall have their automatic interlock switch which disconnects power and discharges the cell when the access door is opened. In addition, the EAC shall be capable of interlocking when disconnecting the power to each individual EAC unit, or when the AHU fan is not running.

A high voltage test button shall be provided for each individual high tension power supply unit to indicate the presence of high voltage on the electronic cells. An overall test button for a group of power supply units to provide a general indication of high tension voltage is not approved.
The average capacity of the EAC shall be at least 1000cfm for the single cell unit and 2000cfm for the double cells unit.

The initial atmospheric dust spot efficiency (ASHRAE 52-76) of the EAC shall be at least 67% at 2000cfm and up to 95% at 800cfm. The proposed equipment shall be capable of capturing sub-micron particulates/contaminants down to 0.3 microns. All tenderers shall submit test results of filtration efficiency by Air Filter Testing Laboratories for efficiency verification.

The solid state power supply shall provide dual voltage to the ionizer and collector section. The voltage to the ionizer shall be at least 8000V DC to create an intense electrostatic field to allow maximum transfer of electrical charge from the ionizing wires to air particles. The voltage to the collector shall be at least 4000V DC.

For the EAC to perform effectively against PM 2.5 pollutants, the EAC shall have a fractional efficiency test report from a third-party testing laboratory to confirm CME (Composite Minimum Efficiency) of the following:

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>CME</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 to 0.4 µm</td>
<td>68%</td>
</tr>
<tr>
<td>1.0 to 1.3 µm</td>
<td>89%</td>
</tr>
<tr>
<td>2.2 to 3.0 µm</td>
<td>94%</td>
</tr>
</tbody>
</table>

The entire filtration system shall be washable and reusable without need for replacements. Electrostatic media filters that collect particles on disposable media pads shall not be acceptable.

The average initial pressure differential drop across the entire filtration system shall not exceed 65 pa at 2000cfm and 2.5 m/s airflow. The tungsten ionizing wires and aluminum collector plates shall be integrated within one pack. A washable aluminium mesh prefilter shall be provided at the inlet to trap all larger sized particles.

Filter cells shall be universal to allow for a single inventory of filters as spare parts.
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The EAC shall be completed with Hot- dipped Galvanized cabinet to protect against rust, heavy duty commercial used electronic cells, solid state power supply, protective screen and prefilter. A washable aluminium mesh prefilter shall be provided at the inlet to trap all larger sized particles.

The EAC shall have the capability for the optional addition of activated carbon (Charcoal) filter for the removal of gaseous contaminants and odours. The activated carbon filter shall be able to reside into the EAC cabinet as and when necessary; no modification for the initial installation shall be allowed.

Diagnostics / Interfacing to Building Management System

The EAC shall have the capability of interface with the building management system through a Solid State Performance Indicator (SSPI). The following status shall be allowed for remote monitoring by the building management system as common fault:

1. Normal operation of solid state power supply (ON)
2. Any malfunction of the system that shall cause an alarm activation (CHECK)
3. Excessive dirt accumulation in the collector cells that could result in the reduction of the EAC performance (WASH)

The EAC shall have local LEDs at each individual unit to indicate the above status and it shall be able to provide in addition a signal to link-up with the building management system for monitoring.

Submission of Compliance Documentation

Tenderers must submit a Clause-by-Clause Compliance Summary and provide full documentation/technical literature/data sheets/reports to confirm compliance for each clause. Please also submit a project reference list.
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12 11. FAN COIL UNITS

11.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of fan coil units conforming to these Specifications and in accordance with the requirements of the Drawings and Schedule of Quantities.

11.2 TYPE

The fan coil units shall be vertical type for floor mounting, horizontal type for ceiling-suspension. Floor-mounted vertical units shall have vertical top discharge; and horizontal units mounted within ceiling space shall have horizontal discharge and shall be ductable. All units shall be complete with chilled water coil, one or more centrifugal fans and motor, cleanable fabric filters, insulated condensate drain pan.

11.3 CAPACITY

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

11.4 CABINETS

Cabinets for floor mounted exposed FCU shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bonderized and painted with approved shade of powder coating finish. The cabinets shall be of sufficient size to enclose all piping and control valves, and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal.

Horizontal furred-in type units mounted within ceiling space shall be provided with a GI casing of 18 gauge, the coil and fan section with provision to mount filters within the fan section.

12.1.1.1

11.5 INTERIOR CHASSIS

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bonderized and painted with approved shade of powder coating finish. All ceiling suspended vertical fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.
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11.6 DRAIN PAN

Primary drain pan shall be pre-pressed 22 gauge SS-304 and an additional inner bottom panel of 22 gauge SS-304 shall be provided to prevent damage to, and floatation of the bottom panel insulation. The pan shall be insulated with not less than 6 mm thick nitrile rubber (class O as per BS 476) insulation shall be effective to prevent condensation. The pan shall be of sufficient size to catch all drippage of condensation from any part of the unit. In all cases pan shall be large enough to cover cooling coil supply and return water headers and bends, control valves and ball valves with copper pipes. A secondary (auxiliary) condensate pan similar to primary drain pan may be provided by the manufacturer of these units which are so identified in Schedule of Quantities. All drain pans shall be with powder coating finish as per interior chassis defined above.

11.7 COOLING COIL

All cooling coils shall be standard three-row staggered seamless copper tube with aluminum sine wave fins. The coil shall be fitted with dielectric coupling for connection with MS pipes by HVAC contractor. Tubes shall be minimum 10 mm OD and wall thickness shall be minimum 0.41 mm. Fin spacing shall be 12 fins per inch. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Tubes shall be mechanically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from back side of FCU along with fan section without disturbing the Installations. All coils shall be factory tested at 21 KG per sq. cm (300 psig) air pressure while submerged in water.

11.8 FANS

Fans shall be centrifugal forward curve DIDW, direct driven by a fractional horse power shaded-pole motor.

11.9 MOTOR

Motor shall be 220 ± 6% volts, 50 cycles single phase, energy efficient, six pole, shaded pole type, speed not exceeding 1000 rpm at maximum airflow. Motors shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

11.10 INSTALLATION
Ceiling suspended horizontal units and units mounted within the ceiling space shall be hung through rubber-in-shear vibration isolator suspenders.

11.11 ACCESSORIES

All fan coil units shall be equipped with copper piping connections, dielectric union and manual air vent at the cooling coil outlet header. In addition, the following accessories may be required at fan coil units; their detailed Specifications are given in individual sections and quantities separately identified in Schedule of Quantities.

12.1.1.2

a. Imported fan coil units as specified in Schedule of Quantities shall be factory fitted with Ball valves at inlet and outlet. Ball valve with ‘Y’ strainer shall be installed in the tapping of the chilled water pipe installed in riser/shaft or as shown on Drawings and in Schedule of Quantities.

b. ALTERNATELY Ball valve with ‘Y’ strainer, and ball valve as shown on Drawings and in Schedule of Quantities.

c. Adjustable discharge air grille as shown on Drawings and in Schedule of Quantities.

• 11.12 PAINTING

4. Shop coats of paints that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

• 11.13 PERFORMANCE DATA

5. Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium/high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

• 11.14 TESTING

Cooling capacity of various fan coil unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and
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quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.
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13 COOLING TOWERS

COOLING TOWER

12.1 SCOPE OF WORK

This specification covers the design requirement, materials, constructional feature, manufacture & supply, installation, testing, commissioning of CTI Certified FRP Cooling Towers.

12.2 CODES & STANDARDS

The design, materials, manufacture, testing & performance of cooling tower shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed. The cooling tower shall also conform to the latest application of International Standards & shall meet / exceed ASHRAE 90.1-2004 performance standards.

Cooling Tower shall be CTI approved for thermal performance and shall carry CTI certification label and also listed in the CTI directory of certified cooling towers. The performance shall comply with CTI standard 201. Sound performance shall be in accordance with CTI ATC-128 and as per tender BOQ specification Heat rejection Performance shall be in accordance with ASHRAE 90.1-2013.

Seismic design requirements shall be in accordance with relevant provisions of IS Code/ National Building Code of India.

12.3 TYPES & CAPACITY OF COOLING TOWER

The cooling tower shall be induced draft, cross flow type conforming to their respective specification & of rectangular / square profile. Each cooling tower actual capacity shall be as specified in BOQ.

12.4 CONSTRUCTIONAL FEATURE OF COOLING TOWER

The induced draft cross flow FRP cooling tower shall be complete with FRP casing, fill, internal supporting structure, drift eliminators, fan, fan motor, hot water distribution system & cold water basin. All steel components including assembly hardware shall be hot dip galvanized (G-235 Grade). Suitable access shall be provided for the inspection & maintenance of fan. The design of louvers, fill & drift eliminators shall ensure minimum resistance to flow of air. The induced draft axial / propeller fan of the cooling tower shall be belt / direct driven by TEFC squirrel cage motor located DDFCONSULTANTSPVT.LTD.
inside/outside the moist air stream. The fill sheet includes both louvers and drift eliminators & the louvers should prevent water from escaping the fill sheets to assure proper & efficient heat transfer throughout wide variations in the airflow. Drift losses for the cooling tower should not be more than 0.00091% of the circulated water. Suitable screens between the side of the cold-water basin & the base of the fill should be provided to prevent foreign materials in the circulating water flow & should be easily removable. The fan motor shall be suitable for 415 volts ±10%, 3 phases, 50 Hz ± 5%, AC supply conforming to IP 55.

12.5 COLD WATER BASIN

The cold-water basin shall be a deep fibre glass reinforced sump on which cooling tower structure shall be supported. Basin fittings shall have the following.

i) Bottom Outlet.
ii) Screened suction assembly fixed to the basin.
iii) Drain at under side of suction, suction side sheet.
iv) Overflow fixed to inside of casing side sheet.
v) Equalizing connection & balancing valves for multiple CTs as required.
vi) Quick Fill arrangements

12.6 MECHANICAL EQUIPMENT

The cooling tower shall be provided with low speed, low noise, and acoustically treated fans running at lower RPM through direct driven/ Belt driven motor. Fan speed shall not be more than 750 RPM/ OEM Std. Fan shall be of the axial/propeller type lightweight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be statically and dynamically balanced. Fan shall be driven by TEAO motor suitable for 415 volts ±10%, 3 phases, 50 Hz ± 5%, AC supply conforming to IP 55. Fan motor shall be energy efficient motor weatherproof construction, designed and selected to operate in humid air stream. Fan guard shall be provided to prevent birds from nesting during idling periods. G.S.S canopy shall be provided over the fan motor for protection against rainwater. Care shall be taken that fan air is not restricted. Motor terminal box shall be made watertight.

VFD shall be provided for each motor if specified in BOQ.

12.7 FILLINGS:
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The Fillings shall be made of corrosion proof and rigid film in cross fluted design and arranged in square / rectangular form and shall be elevated from the floor of the cold water basin to facilitate cleaning and easy replacement. They shall be arranged in such a manner to ensure negligible resistance to airflow and to eliminate backwater spots and prevent fouling trough scales that may form. In order to reduce carry-over losses through entrapment of water droplets in air stream, PVC drift eliminators shall be installed.

12.8 DISTRIBUTION HEADER

Hot Water distribution system shall be open basin, flume and troughs, or a pipe system with nozzels spaced for even distribution of water over fill surface. System shall be self-draining and non-clogging. Spray nozzles, shall be cleanable, bronze or high impact plastic, non-clog, removable type properly spaced for even distribution. Cover shall be provided for entire nozzle area or flume / trough area.

13.1 12.9 COOLING TOWER FILL

Fillings- Louvers & Drift eliminators shall be formed from self-extinguishing ( per ASTM-568 ) PVC of 13 mil thickness having flame spread rating of 5 per ASTM E84 and shall be impervious to rot, decay, fungus and biological attack and thermo vacuum formed with honeycomb design to facilitate for an even spread of water over fill heat transfer surface. The fill shall be suitable for entering water temperatures up-to and including 130 deg F. Fill sheets shall either be suspended from tower deck structure under side & shall be elevated above the floor of the cold water basin to facilitate cleaning and easy replacement for cross flow towers or shall be bonded together in blocks for easy removal and replacement for counter flow towers. Fill shall be arranged in such a manner to ensure negligible resistance to air flow and eliminate water spots and prevent fouling through scales that may form.

12.10 ACCESSORIES

The cooling tower basin shall be provided with automatic float valve with a stop valve for continuous make up water flow, quick fill arrangement with stop valve, over-flow and drain connections with stop valves. A hot water bleed connection to the drain line through a stop valve shall be provided. It shall be connected to the drain line below the drain stop valve. Steel ladders & Hand rails shall be provided in such a manner and location as necessary to give safe and complete access to all parts of tower requiring inspection. Each ladder shall be made of iron sides and 16 mm straps and shall be bolted to the tower on the top and grouted in masonry at the bottom end. All
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Hardware used shall be of stainless steel. All pipe connections shall be hot dip galvanized and double flanged.

12.11 STEEL/PAINTING SURFACE

All exposed steel surfaces shall be Galvanized steel in G235 grade & the color finish of cooling tower shall as per manufacturer standard requirement.

12.12 PERFORMANCE DATA:

The complete performance ratings and power consumption at varying outdoor wet bulb temperatures shall be submitted and verified at the time of testing and commissioning of the installation. The Capacity of the cooling tower shall be computed. The performance required for cooling tower is minimum 81 GPM/HP when tested according CTI ATC-105 procedure.

12.13 TESTING:

Cooling tower being critical equipment for proper functioning of chillers, strict quality control is required. Capacity of the cooling tower shall be computed from the measurements of water flow, incoming/outgoing water temperatures and ambient air wet bulb temperature using accurately calibrated thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption for cooling towers shall be computed from measurements of incoming voltage and input current.
13. **PIPING**

13.1 **SCOPE**

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the Drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards. All welders used for piping erection shall be well qualified (certificate should be submitted to Project Manager for approval) and shall have minimum 8 to 10 years’ experience.

13.2 **PIPE SIZES**

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor’s guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids.

13.3 **CHILLED, HOT AND CONDENSING WATER PIPING**

Following material shall be used for pipes and fittings.

<table>
<thead>
<tr>
<th>Pipes Nominal size (mm)</th>
<th>Material Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;150</td>
<td>IS 1239 Part-1</td>
</tr>
<tr>
<td>200 and above</td>
<td>IS 3589 Gr. FE 410 (6mm thick)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fittings Nominal size (mm)</th>
<th>Material Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>Socket welded, ASTM A105 as per ANSI B16.11</td>
</tr>
<tr>
<td>50-150</td>
<td>Butt welded, ASTM A234 Gr. WPB as per ANSI B16.11</td>
</tr>
<tr>
<td>&gt;200</td>
<td>Site fabricated from IS 3589 Gr. FE 410 (8mm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flanges Nominal size (mm)</th>
<th>Material Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 150</td>
<td>IS 2062 Gr.A as per ANSI B16.5 (#150 class)</td>
</tr>
<tr>
<td>&gt;200</td>
<td>IS 2062 Gr.A, as per ANSI B16.5 (#150 class)</td>
</tr>
</tbody>
</table>

a. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS Code of practice for manual metal arc, welding of Mild Steel.

Out of three weld one butt weld of each welder shall be fully radiographed for testing purposes. Upon approval of welding joints the concerned welder shall
be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

All welded joints (except pipe welded end-to-end) shall be made by use of one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following:

- All joints shall have 45 degree bevel type, pipe mill-beveled or machine-beveled by the contractor.
- All scale and oxide shall be removed with hammer, chisel or file and bevel left smooth and clean.
- Pipe lengths shall line up straight with abutting pipe ends concentric.
- Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means so as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.
b. All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. For vibration isolators pre-molded polyurethane pipe sections of 160 Kg/m³ density with adhesive shall be fixed between pipe and MS support. 10 mm thick MS ‘U’ clamp with resistoflex shall be fixed on the pipe so that the pipe is kept in position. All welded piping shall be subject to the approval at site.

c. Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. These shall form part of piping and are not separately identified in Schedule of Quantities.

d. 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.

e. Ball and butterfly valves conforming to the following specifications shall be provided as shown on Drawings:

<table>
<thead>
<tr>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 to 25 mm</td>
<td>Bronze</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 mm and over</td>
<td>Body Cast iron,</td>
<td>Wafer</td>
</tr>
</tbody>
</table>

Type and requirements shall be as indicated in Schedule of Quantities. Valves shall have non-rising spindles unless specified otherwise and shall be suitable for PN 16 rating. Butterfly valve should be of wafer type long neck construction single stem design with center lugs to ensure proper alignment of pipe flanges. Mount valve onto flanges only after flanges have been welded to pipes using a tool piece and cooled down to room temperature to prevent damage to resilient seat. The rubber liner should be fully supported by the valve flanges. Appropriate dimensions and thickness of Flanges and Bolts, as per the Flange Tables ANSI B16.5 (#150 class), should be used. The flanges should be properly aligned with each other so that bolts are exactly perpendicular to the flanges. Evenly tighten the flange bolts to secure the valves. Counter flanges with nut-bolts and gaskets shall be provided by valve manufacturer.
f. Butterfly valves shall perform the function of isolating valves and shall be suitable for PN16 rating. Butterfly valves shall have Epoxy Coated cast iron body with Integrally molded EPDM liner of replaceable type. The liner shall be integrally molded on hard backup ring and shall be suitable for PN16 rating unless specified otherwise. All butterfly valves shall be provided with locking devices. Valves 250 mm and above dia shall be gear driven.

g. Automatic balancing valves shall automatically control flow rates with ± 5% accuracy. Valve control mechanism shall consist of a stainless steel cartridge with a ported cup and coil / helical spring to avoid corrosion. Four operating ranges shall be available with the minimum range requiring less than 14 kPa to actuate the mechanism. Manufacturer shall provide independent laboratory tests verifying assurance of performance.

h. Balancing cum control valves shall be sized based on flow rates and pressure drops across cooling coil.

• i. Manual double regulating balancing valves shall be provided at chiller, condenser, various tapp-offs and each AHU outlet line as indicated in Schedule of Quantities. These valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation. To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programme to provide the following functions:
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- i. To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

- ii. To store the results of balancing.

- iii. To log measured values from a valve (differential pressure, flow rate or temperature).

- iv. To printout saved data in computerized measurement protocol (CMP) consisting of:
  - Name and size of Balancing Valve (BV)
  - Presetting position of BV
  - ΔP at BV
  - Flow at BV
  - Design Flow

k. Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable asbestos fibre / rubber insertion gaskets (minimum 3 mm thick).

l. All ball valves and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions. These are separately identified in Schedule of Quantities.

m. Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications:

<table>
<thead>
<tr>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 to 300 mm</td>
<td>Body: Grey Cast iron (Epoxy Coated), CI IS 210 Gr. FG 260</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plates: CF-8 (SS-304), Hinge/Stop Pin: SS-410</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring(s): SS-316. Seal: EPDM</td>
<td></td>
</tr>
<tr>
<td>350 mm to 500 mm</td>
<td>Body: Grey Cast iron Flanged</td>
<td></td>
</tr>
</tbody>
</table>

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(Epoxy Coated),

CI IS 210 Gr. FG 260

- Plates: SS-409.
- Hinge/Stop Pin: SS-410
- Spring(s): SS-316.
- Seal: EPDM

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be PN 16 rating.

Strainers shall be ‘Y’ type or Pot Strainer suitable for PN 16 rating as shown on drawings and included in BOQ. ‘Y’ Strainer shall be fabricated out of MS ‘C’ class pipe two sizes higher than that of Strainer pipe size. Flanges as per ANSI B16.5 (#150 class) shall be provided at inlet and outlet connectors. The body shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gage SS sheet with 3 mm perforation. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and included in BOQ.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet/outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and included in BOQ.

The strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gage SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently large drain pipe with butterfly valve shall be provided at the bottom chamber to flush-out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint water tight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.
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Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as under:

<table>
<thead>
<tr>
<th>Pipe size (mm)</th>
<th>Pot Dia (mm)</th>
<th>Pot HT (mm)</th>
<th>Element Dia (mm)</th>
<th>Element HT (mm)</th>
<th>MS Plate Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>610</td>
<td>815</td>
<td>400</td>
<td>470</td>
<td>8</td>
</tr>
<tr>
<td>250</td>
<td>800</td>
<td>955</td>
<td>550</td>
<td>510</td>
<td>8</td>
</tr>
</tbody>
</table>

Each Port strainer shall be provided with a Test Certificate.

o. All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section “Insulation”.

p. Grooved coupling: Grooved coupling shall have 3 main parts viz. Housing, Gasket and bolting arrangement. Housing shall be made out of ASTM-A 536 Grade 65-45-10. The housing key shall engage into the grooves around the full pipe circumference, securing the pipe ends together with positive grip. Housing shall be designed to provide optimum combination of pressure, stress relief and end load conditions while maintaining reasonable weight. Gasket shall be of high sealing efficiency and shall be able to withstand upto (-) 0.35 Bar pressure. Bolt shall confirm to ASTM A183, while nut shall confirm to ASTM A194. Nut-bolt shall be electro-galvanized.

13.4 PRESSURE INDEPENDENT BALANCING CUM CONTROL VALVES/HIGH RANGABILITY VALVES

Each Air Handling Unit / Fan Coil Unit shall be provided with 2/3Way Pressure Independent Balancing Cum Control Valve with Integrated in a single Body with Globe Type in Construction.

Control - Valve should be equipped with electronic modulating actuator which can accept either 0(0)-20 mA / 2(0)-10 V DC signals. Operating voltage for actuator shall be 24V AC. Delta p controller
should ensure 100% valve authority at all loads (part load Actuator shall be able to work against maximum closing pressure of 6 Bar at full load). With feedback signal to Control system. 230/24V transformer shall be included.

Balancing – Each Valve should have steeple adjustable maximum flow limitation as per the designed flow rate of coils. Balancing should be done only in Valve not in actuator so that at any given condition of failure balancing is not lost and easily accessible.

All Valve actuator shall be microprocessor based with self-calibrating feature. Valve should be of linear control characteristics with step-less characteristics.

### Actuator Specifications for All Sizes

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>24V AC (230/24 Transformer shall be included)</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>10V AC Max.</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 HZ</td>
</tr>
<tr>
<td>Control Input</td>
<td>2-10V DC, 4-20mA, 3-point Selection.</td>
</tr>
<tr>
<td>Position Output</td>
<td>2-10V DC 4-20mA</td>
</tr>
<tr>
<td>Body Housing Insulation</td>
<td>Non Corrosive - IP 42 Till DN 40 &amp; IP 54 Till DN 50 To 150.</td>
</tr>
</tbody>
</table>

**Valve Body and Characteristics:**

1. Pressure Controller Device should maintain the Pressure irrespective of Fluctuation with the help of Diaphragm self-adjusting type and should not be in contact with each other.

2. Control valve shall accurately control the flow, with help of Modulating Actuator

3. All Valve Sizes should have a Testing Port Device for verifying accuracy of flow performance with respective of Differential Pressure.


**Valve Actuator and Housing:**
5. The Valve + Actuator must have ability to undertake both Logarithmic Control Characteristics and Linear Control Characteristics. This shall ensures compatibility for both Water/Air and Water/Water Heat Exchange.

6. Valve Actuator housing shall made of non-Corrosive (Aluminum) Material. Valve actuator housing shall be IP Protection (Weather Proof: Dust & Water Protected). Valve actuator housing shall be acceptable to IP 42 Till 40MM and above should be IP54.

7. Control/Dip Switch Setting should be easy to Manual Access to avoid Manual Contact to directly with Integrated IC Circuit of the system.

8. Actuator should not play a part in balancing process.

Valve Flow Balancing:

9. Balancing & Control: Balancing should be accomplished by the Diaphragm and Control should be taken care by Actuator receiving signals from Room Thermostats or BMS.

10. Manual Override Flow Balancing should only be done in Valve, not in actuator and should not involve opening of actuator Body.

- Flow Setting Balancing (Commissioning) for the Valves should be simple and fool proof.
- Should not involve opening of the actuator.
- Should not need compulsory involvement of high end technicians.
- Should avoid direct Manual Contact with Integrated Circuit (IC) of the actuators.

A. AIR&DIRTSEPARATOR:

The Air and Dirt separator shall be of solid and robust construction (Mild Steel). It shall be able to remove free air and microbubbles as well as remove solid particles up to 5 microns from water at velocity between 2-3 m/s. Removal of Air & dirt shall be through coalescence. The unit shall be able to condition the water to make it highly absorptive at all points in the system. This ensures that microbubbles cannot exist at any point in the system. All connections, fittings, and heads shall be of carbon steel. The medium used to de-aerate and remove dirt shall be manufactured from Steel Tube & a mesh made of copper wire. This medium should be non-clogging in nature. An automatic air vent of at least 100 mm free area to be connected at the top for the release of the air separated from the water. The flow should not be obstructed by the dirt collected. A drain valve should be present at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system. The Air & Dirt Separator shall be insulated depending upon its location (outdoor or indoor). The pressure drop on account of the air and dirt separators shall not exceed 21 kPa.
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maximum flow of the chilled water system. The performance of the air & Dirt Separator shall be confirmed by TNO report.
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B. CLOSED EXPANSION TANK:

The Expansion Tank will be of M.S Construction with interchangeable EPDM-Butyl rubber membrane & with preferably suitable for grooved connection.

The expansion tank will be of pressure rating to suit the system pressure & will be sized (as specified in BOQ) to adequately compensate for water expansion due to operating temperature variation.

The expansion tank will be complete with safety relief valve, pressure reducing valve, pressure gauge & other accessories.

The expansion tank will be insulated as per the section “Insulation”.

Centrifugal Air Separator: It will be of M.S construction with preferably suitable for grooved connection. The Air separator will be of pressure rating to suit the system pressure & will be sized (as specified in BoQ) to achieve maximum air separation.

The Air Separator will be complete with Automatic Air vent at the top & drain valve in the center of the bottom.

The Air separator will be insulated as per the section “Insulation”.

13.5 COLD WATER AND DRAIN PIPING

a. All pipes to be used for cold water (makeup), drain, condensate drain and fittings shall be galvanized steel class ‘B’ (medium class) conforming to relevant BIS Codes.

b. All jointing in the pipe system shall be by screwed joints and/or by screwed flanges using 3 mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.
c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.

d. Fittings shall be galvanized steel ‘medium class’ malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing tees. All equipment and valve connections, or connections to any other mating pipes shall be through flanges required for the mating connections. Fittings & flanges shall form part of piping and are not separately identified in Schedule of Quantities.

e. Gate valves, globe valves, check valves and strainers shall be similar to those specified for chilled, condensing and hot water piping.

f. For proper drainage of AHU Condensate, ‘U’ trap shall be provided in the drain piping.

g. All condensate drain piping shall be insulated and painted as per the section “Insulation” as indicated in Schedule of Quantities.

13.6 PIPING INSTALLATION

- a. Design Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in the building through which pipes are designed to pass.

- Pipe shall be cut only with hack saw blades and welding rods shall not be used for this purpose. All the pipes shall be cleaned and applied with one coat of Zinc chromate primer.

- b. Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency.

All pipes in HVAC plant room shall be supported with pipes and channels from floor only with necessary PUF pipe supports and resistoflex sheet.
c. Pipe supports shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following:

<table>
<thead>
<tr>
<th>Pipe size Rod Size</th>
<th>Spacing between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Upto 12 mm</td>
<td>1.5 Meter 10 mm</td>
</tr>
<tr>
<td>15 to 25 mm</td>
<td>2.0 meter 10 mm</td>
</tr>
<tr>
<td>30 to 150 mm</td>
<td>2.0 meter 10 mm</td>
</tr>
<tr>
<td>Over 150 mm</td>
<td>2.5 meter 12.5 mm</td>
</tr>
</tbody>
</table>

d. Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on alternate floor. MS cleats shall be welded on pipes and rest on MS channel placed on the floor with 15 mm thick resistoflex pads between the cleat and channel. U clamps with resistoflex sheet shall be provided to keep the pipe in position.

e. Bull heading in water/refrigerant piping shall be avoided.

f. Pipe sleeves atleast 3 mm thick, 50 mm / 100 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fibreglass and finished with retainer rings welded on the ends of the sleeve.

g. Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant such as fire barrier caulks.

h. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gage metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15 cm on both sides of the clamp, saddles or roller.

i. All piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.
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j. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.

k. 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 where required.

l. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges bevelled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

m. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres, or where-ever shown in Approved-for-Construction shop drawings, to facilitate future cleaning of all welded pipes.

n. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fibre glass tissue, each layer laid in bitumen.

o. Insulated buried pipes shall be cleaned, derusted, then coated with Zinc chromate primer and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. Insulation shall be applied as per the section “Insulation”, wrapped with GI wire and covered with polyethylene sheet. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in Schedule of Quantities, buried insulated pipes shall be water-proofed using coat of Shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fibre glass RP tissue and one layer of roofing tarfelt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage G.I wire tied at 15 cm intervals.

p. Auto purge valves shall be provided at all highest points in the piping system for venting air. Air valves shall be 15 mm pipe size with screwed joints.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.
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- a. Pressure gages as specified under section “Automatic Controls and Instruments” shall be provided at suction and at discharge of each pump, at chilled water supply and return at each air handling unit, at each chillers and condenser, and as shown on the Drawings and included in Schedule of Quantities. Care shall be taken to protect pressure gages during testing. Pressure gage sockets on insulated pipes and accessories shall be extended upto insulation to avoid damage of insulation for replacement of gages.

- b. Thermometers as specified under section “Automatic Controls and Instruments” shall be provided at chilled water supply and return at each air handling unit, at each chiller and condenser, and as shown on Drawings and included in Schedule of Quantities.

- c. Thermometers on CHW lines shall be with long stem. Thermometer socket shall be extended upto insulation thickness so that the thermometer shall be removable without damaging the insulation.

13.8 TESTING

a. During construction, the contractor shall properly cap all lines, so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed thoroughly after completion (for the purpose of removing dirt, grit, sand etc. from the piping and fittings) for as long a time as is required to thoroughly clean the system.

b. All piping shall be tested to hydrostatic test pressure of atleast two times the maximum operating pressure, but not less than 16 kg per sq. cm gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified, retested and gotten approved.

- c. Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

- d. Piping may be tested in sections and such sections shall be securely capped, then re-tested for the entire system.

- e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by department representative.
f. The contractors shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser/chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.

g. The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re-finishing of floors and walls if required.

h. After the piping has been installed, tested and run for atleast three days of eight hours each, all insulated exposed piping in plant room shall be given two finish coats, 3 mils each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to Insulation section.

i. After testing, all systems shall be chemically cleaned. Chemical cleaning shall be carried out in 3 stages. In first stage biological cleaning shall be done to remove algae, bacteria, SRB etc which produces slimes. Second stage is pre-cleaning in which loose rust, oil, and debris are removed. Chemical addition and hold up time shall be as per chemical supply agencies recommendations. Third stage is passivation, in which chemicals will be added and passivation film will be formed over inside surfaces of piping system. Type of chemical used and quantity of the same along with detailed method statement shall be submitted by contractor before starting this activity.

Before handover department site representative shall be provided with certificate of cleaning of pipe systems, signed by the contractor.

k. The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

13.10 Balancing

a. After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.

b. All balancing valves, Automatic control valves and two-way diverting valves shall be set for full flow condition during balancing procedure. Each water circuit shall be adjusted thru balancing valves provided for this purpose; these shall be permanently marked after balancing is completed, so that they can be restored to their correct positions, if disturbed.
c. Complete certified balancing report shall be submitted for evaluation and approval by department site representative. Upon approval, four copies of the balancing report shall be submitted with the as-installed drawings and completion documents.

13.11 VALVE IDENTIFICATION

Provide 30 mm dia brass valve tag, with embossed letters and number for each valve and attach the tag to valve handle by “S” hook or by suitable means. Contractor shall provide valve tag schedule and valve chart for each piping system, consisting of schematic drawing of piping layout, along with a valve list, showing and identifying each valve by number, service and location and describing its function.

The contractor shall frame under glass in the air-conditioning plant room or as directed by department site representative two copies of valve chart. Two additional unmounted copies shall be supplied to the department site representative.

Tags shall correspond with the valve schedule and record drawings. In back of house areas, where ceilings are installed and the valve or valve tag is not visible, a self-adhering tag with the valve number shall be installed on the wall or directly under the ceiling. For public area ceiling valves, these tags are to be installed in the service corridor, leading to the public areas.

13.12 MEASUREMENT FOR PIPING

The measurement of pipes shall be done as described in the CPWD specification for HVAC Works-2004.
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14 14. FANS

14.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

14.2 TYPE

Centrifugal, in-line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

14.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

14.4 CENTRIFUGAL FAN

Centrifugal fan shall be DWDI / SWSI Class I construction arrangement 3 (i.e. bearings on both the sides) for DWDI fans complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for-Construction shop drawings.

a. Housing shall be constructed of 14 gage sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / asbestos packing should be provided throughout split joints to make it air-tight.

18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

b. Fan Wheel shall be backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. For fans upto 450 mm dia, fan outlet velocity shall not exceed 550 meter/minute and maximum fan speed shall not exceed 1450 rpm. For fans above 450 mm dia, the outlet
velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

c. Shaft shall be constructed of steel, turned, ground and polished.

d. Bearings: shall be of the sleeve / ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.

e. Motor: Fan motor shall be energy efficient and suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled motor, provided with class F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. Motor shall be designed specially for quiet operation and motor speed shall not exceed 1440 rpm. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), so that sound level is lowest.
14.5 AXIAL FLOW FAN

<table>
<thead>
<tr>
<th>HP</th>
<th>POWER FACTOR</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
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</tr>
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</tr>
<tr>
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<td>0.87</td>
<td>0.85</td>
</tr>
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</table>

f. Drive to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belts shall be of the oil-resistant type.

g. Vibration Isolation: MS base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through resistoflex vibration isolators. The concrete foundation shall be at least 15 cm above the finished floor level, or as shown in approved-for-construction shop drawings.
CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT. MEDICAL COLLEGE AT BALANGIR, ODISHA

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

6. a. Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.

7. An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

b. Rotor: hub and blades shall be cast aluminium or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

c. Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, provided with class ‘F’ insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

<table>
<thead>
<tr>
<th>HP</th>
<th>POWER FACTOR</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FL</td>
<td>3/4L</td>
</tr>
<tr>
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<td>1.00</td>
<td>0.76</td>
<td>0.67</td>
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</table>

DDFCONSULTANTSPVT.LTD.
| QTY (kW) | D | D | F | C | O | N | S | U | T | A | N | T | S | P | V | T | L | T | D. |
| 1.50    | 0.77 | 0.70 | 0.57 | 83.80 | 83.80 | 80.00 |
| 2.00    | 0.77 | 0.70 | 0.57 | 85.00 | 85.00 | 81.00 |
| 3.00    | 0.82 | 0.74 | 0.60 | 86.40 | 86.40 | 84.00 |
| 5.00    | 0.82 | 0.78 | 0.63 | 88.30 | 88.30 | 86.00 |
| 7.50    | 0.85 | 0.80 | 0.71 | 89.50 | 88.50 | 88.00 |
| 10.00   | 0.86 | 0.83 | 0.76 | 90.30 | 90.30 | 89.00 |
| 12.50   | 0.84 | 0.82 | 0.73 | 90.50 | 90.50 | 88.00 |
| 15.00   | 0.85 | 0.83 | 0.76 | 91.50 | 91.50 | 89.50 |
| 20.00   | 0.85 | 0.83 | 0.76 | 92.20 | 92.20 | 91.00 |
| 25.00   | 0.85 | 0.82 | 0.76 | 92.40 | 92.40 | 91.00 |
| 30.00   | 0.85 | 0.80 | 0.72 | 92.80 | 92.80 | 92.00 |
| 40.00   | 0.86 | 0.85 | 0.80 | 93.20 | 93.20 | 91.00 |
| 50.00   | 0.87 | 0.85 | 0.77 | 93.60 | 93.60 | 91.60 |
| 60.00   | 0.88 | 0.86 | 0.78 | 93.90 | 93.90 | 91.90 |
| 75.00   | 0.87 | 0.85 | 0.78 | 94.20 | 94.20 | 92.80 |

d. Drive: To fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

e. Vibration Isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.

f. Accessories: The following accessories shall be provided with all fans:

- i. Outlet cone for static pressure regain.
- ii. Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.

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CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT. MEDICAL COLLEGE AT BALANGIR, ODISHA

14.3 Axial Flow Fan shall be AMCA certified for Air and Sound performance in accordance to AMCA 210 and AMCA 300

Axial Flow Fan (for Fire, Smoke)

The fans shall be of the direct drive axial type with cast aluminum aerofoil propellers and shall be suitable for mounting in duct or floor/slab as required/indicated on the tender drawings. The casing shall be constructed of continuously welded steel and include integral punched inlet and outlet flanges to prevent air leakage and shall withstand 250 degree 2 hours. The casing and motor base shall be constructed and formed members of heavy gauge steel to prevent vibration and rigidly support the motor. Motor support brackets shall be welded to fan casing for increased strength. Motors for emergency fire, smoke and heat ventilation shall certified according to stand BS EN 12101-3:2002 for 250°C for 2 hours.

Blades shall be aerofoil design. Hub and blades shall be a high strength cast aluminum alloy and shall withstand 250°C for 2 hours. Blade pitch shall be manually adjustable without removing from the fan casing. Rotors shall be statically and dynamically balanced.

All Fan casing are with integral punched flanges for sizes up through size 1600mm dia and shall be constructed of rolled steel with a continuous seam weld. Casing to be coated with a minimum of 2 coats of high temperature paint or Powder coated after phosphating process. Motor support framework to be constructed of structural steel that is suitable to handle the weights of the motor and propeller. Motor supports within the fan housing to be welded to the fan casing. Bolted construction is not acceptable. The impeller and fan casing shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

Complete Fan assembly (Fan Impeller, Fan Casing, Motor base frame along with Motor) shall be tested and approved by Exova Warring ton fire in accordance with BS EN 12101-3:2002 standard for "Powered Smoke and Heat Exhaust Ventilators for Smoke Control Systems" for (250°C) temperature for 2 hours of operation.

14.6 AHU FAN SECTION

Ventilation fan sections shall be complete with Centrifugal belt driven fans complete with motor drive and housing with weatherproof cowl.

The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6mm size around the discharge areas. Shaft shall be constructed of steel, turned, ground & polished.

Fans shall be forward/backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fans shall be statically and dynamically balanced. Fans shall conform to specifications as given in specification No. SPC/CF–PF/01

Motors shall be suitable for 415+-10% volts, 50 CPS, 3 Phase AC supply totally enclosed fan cooled motor provided with class ‘F’ insulation & IE-3 class efficiency. Motors shall be designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fans shall be through belts.

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Where called for in Bills of quantities the ventilation fan sections shall be provided with a rattle free backdraft damper to prevent air from re-entering the fan when the fan is not in operation, thus sealing completely in closed position. Dampers shall be chatter proof under all conditions.

The motor and fan assembly shall be isolated from base through Dunlop/Resistoflex vibration isolators.

14.7 PERFORMANCE DATA:

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

14.8 TESTING:

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

The performance of the Fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves :-

i. Airflow capacity
ii. Static head developed
iii. BHP requirement
iv. Vibration and noise level
CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT.MEDICAL COLLEGE AT BALANGIR, ODISHA

15.  **AIR DISTRIBUTION**  
( FOR DUCTS FABRICATED IN FACTORY )

15.1 **SCOPE AS PER “SMACNA” STANDARDS)**

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

15.2 **DUCT MATERIALS**

15.2.1 **RAW MATERIALS**

Galvanizing shall be Class VII – light coating of zinc, nominal 180gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor’s expense.

15.2.2 **GAUGES, BRACING BY SIZE OF DUCTS**

All ducts shall be factory fabricated from galvanized steel / aluminum of the following thickness, as indicated as below :

<table>
<thead>
<tr>
<th>Rectangular Ducts G. S.</th>
<th>Pressure 250 Pa</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Duct Section Length 1.2 m (4 ft)</td>
</tr>
<tr>
<td>Maximum Duct Size</td>
<td>Gauge</td>
</tr>
<tr>
<td>1–750 mm</td>
<td>26</td>
</tr>
<tr>
<td>751 – 1000 mm</td>
<td>26</td>
</tr>
<tr>
<td>1001 – 1200 mm</td>
<td>24</td>
</tr>
<tr>
<td>1201 – 1500 mm</td>
<td>24</td>
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</tbody>
</table>

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15.3  FABRICATION STANDARDS & EQUIPMENT

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

1. Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

2. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

3. All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

4. Kitchen exhaust ducting shall be with 16 G GI welded construction. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood.
15.4  DUCT CONSTRUCTION

5.4.1  All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a.  Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section “Insulation” and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

b.  Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

c.  All ducts up to 75cms width within conditioned spaces shall have C&S connector. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

d.  Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

e.  Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f.  All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

g.  Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT.MEDICAL COLLEGE AT BALANGIR, ODISHA

h. Self-adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

15.4.2 INSTALLATION PRACTICE

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

a) The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner’s site representative in all its parts and details.

b) All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

b) If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner’s site representative.

c) All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, as per below duct hanger details (Schedule-1) of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

d) Alternatively, if mentioned in the BoQ, all ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting.
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casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

e) Ducting over furred ceiling shall be supported from the slab above, or from beams after obtaining approval of Owner’s site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor’s work in the building.

f) Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.

g) All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

h) Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

• 15.4.2 DAMPERS

• a. Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.

• b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

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c. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

e. Pressure relief dampers: Pressure relief dampers shall be constructed with 18G Aluminum construction with parallel blade construction. Leafs shall be 100% air tight upon closure. Leafs shall be loaded with spring pressure of stiffness (k value) corresponding to set point pressure.

f. Non return damper (Back draft damper): Non return damper shall be constructed out of 16G GSS. Blades shall ensure 100% air leak proof performance on closure. Design shall ensure that no rattling noise is produced at design duty.

15.3 FIRE & SMOKE DAMPERS

a. All supply and return air ducts at AHU room crossings and at all floor crossings or as indicated in the drawings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating. These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span.

The dampers shall meet the requirements of NFPA90A, 92A and 92B. Dampers shall have a fire rating of 1.5 Hrs. in accordance with latest edition of UL555 and shall be classified as Leakage Class 2 smoke damper in accordance with latest version of UL555S. Each fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance. Pressure drop shall not exceed 7.5Pa when tested at 300m/min face velocity on 600x600mm size damper. Actuator shall be UL listed.

b. Each damper shall be supplied with factory mounted sleeve of galvanized steel of thickness as per SMACNA and of minimum 500mm long or as specified in schedule of quantities depending up on the wall thickness. The damper shall be fitted in to sleeve either using welding or self-tapping screws. All welded joints shall be finished using heat resistance steel paint. UL listed and approved Silicon sealant shall be applied at all corners as well as at joints between damper frame and sleeve. Damper Frame shall be a roll formed structural hat channel, reinforced at corners, formed from a single piece of 1.6mm galvanized steel. Damper blades shall be airfoil shaped (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Side Jam seals of stainless steel and Top and bottom seals of galvanized steel shall be provided. All galvanized steel used shall be with minimum 180GSM Zinc coating Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in
dimensions of certified module, jack shafted together. Multiple actuators shall be provided for large dampers with higher torque requirements as prescribed in UL.

c. The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct / return air duct. Electric Actuator of suitable Torque and as approved by UL shall be factory mounted and tested. The actuator shall be suitable for 24V AC supply. In addition actuator shall have elevated temperature rating of 250 deg. F. Electric Actuator shall have been energized hold open tested for a period of at least one year with no spring return failure. Each fire/smoke damper shall be equipped with a heat actuated release device which shall allow controlled closure of damper rather than instantaneous to prevent accident. (Electrical fusible link). The EFL shall allow the damper to reopen automatically after a test, smoke detection or power failure condition. The damper shall be equipped with a device to indicate OPEN and CLOSE position of Damper blades through a link mounted on the damper blade.

d. Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:

- Potential free contacts for AHU fan ON/ Off and remote alarm indication.
- Accept signal from external smoke / fire detection system for tripping the electrical actuator.
- Test and reset facility.
- Indicating lights / contacts to indicate the following status:
  - Power Supply On
  - Alarm
  - Damper open and close position.

e. Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with its control panel. Control panel shall be wall mounted type.

f. It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.
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g. HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energising all the smoke detectors with the help of smoke.

h. HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.

i. HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing and installation at site.

j. Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer’s recommendations.

k. The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

15.4 FIRE DAMPERS

a. Whenever a supply/return duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.

b. Fire damper blades shall be one piece folded high strength 16 gage galvanised steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air currents from creating noise or chatter. The blades shall be held in position through fusible link of temp 70°C. The HVAC contractor shall supply UL classified Fire Dampers meeting or exceeding the specifications. Fire Dampers shall be furnished and installed at locations shown in Drawings and as described in Schedule of quantities. Fire Dampers shall have a fire rating of 1.5/3 Hrs. as specified in BOQ, in accordance with latest edition of UL555. Each Fire damper shall be AMCA licenced and shall bear the AMCA seal for air performance.

Damper shall be equipped with UL labelled Fusible Link with Tempreature setting 165 or 212deg. F or as specified in Bill of quantities.Fire dampers shall have been tested to close under dynamic air flow conditions with pressure up to 1000 pa and velocities up to 10.2 m /sec. Fire damper shall be approved for Horizontal or vertical installation as may be required by the location shown in the drawings.

Damper Frame shall be a roll formed structural hat channel, reinforced at corners, formed from a single piece of 1.6mm galvanized steel. Damper blades shall be roll formed 3-v groove (1.6mmthick) or airfoil shaped in case of 3 Hrs. fire rating (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings
shall be of stainless steel fitted in an extruded hole in the damper frame. All galvanized steel used shall be with minimum 180GSM Zinc coating. Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module jack shafted together.

Fire damper shall be equipped with an electric limit switch to indicate open and close position of the damper blades.

Fire Damper shall be installed in wall or floor opening using galvanized steel sleeve of minimum 435mm length of sheet thickness as per SMACNA and as per Installation instruction of Manufacturer.

c. In case of fire, the intrinsic energy of the folded blades shall be utilized to close the opening. The thrust of the suddenly released tension shall instantly drive the blades down and keep it down without the use of springs, weights or other devices subject to failure.

d. Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.

e. The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), as recommended by the manufacturer, at the time of commissioning of the installation.

• 15.5 SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade. The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodised in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described
above shall be provided with flanges on four sides, and the core shall be suitable for clip fixing, permitting its removal without disturbing the flanges.

a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.

b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.

c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and up to 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.

e. All volume control dampers shall be anodised aluminium in mat black shade.

15.6 SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

a. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities. These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.

b. Supply air diffusers with shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.

c. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodised in mat black shade.
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- d. Slot Diffuser shall be extruded aluminium construction multislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

- e. Data centers shall be provided with floor grilles. Grilles shall be of nominal size of 600mm x 600mm and shall be fitted in floor tile of false floor. Grille shall be with dampers for flow control. Grill shall be heavy duty 16G Aluminium and shall take care of human traffic load. Damper shall be operable in situ without requirement of removal of grille.

15.7 FIRE RATED DUCTWORK

- Ducting for kitchen exhaust & fire evacuation shall be fire rated as per following specifications.

- a. All fire rated ductwork constructed for mechanical or dual ventilation / pressurization / basement car park / smoke extract systems and kitchen exhaust shall be fabricated from Lock Forming Quality grade prime Galvanized Steel Sheet, constructed to enhanced SMACNA American/DW144 European standard to either low, medium or high velocity/pressure.

- b. Test requirement of fire rated ductwork should be tested to BS476: Part 24 [1987] and ISO 6944 providing required fire rating for Stability and Integrity.

- c. Stability: the ability of a duct, ductwork & the support system to remain intact & fulfill their intended function for a specified period of time, when tested to the requirements of BS476: Part 24 and ISO 6944.

- d. Integrity: the ability of a duct or ductwork to remain free of cracks, holes or openings out side the compartment in which the fire is present for a specified period of time, when tested to the requirements of BS476 Part 24 ISO 6944.

- e. Insulation: the ability of a duct or ductwork to maintain its separating function without developing temperatures on its external surface outside the compartment in which the fire is present, which exceeds, (i) 140°C as an average value above ambient & or, (ii) 180°C as maximum value above ambient at any point, when tested for a specified period of time to the requirements of BS476: Part 24 ISO 6944.
f. It's important that the fire rated ductwork has a smooth internal surface in order to minimize the pressure loss within the fire rated ductwork system thereby reduce the power requirements.

•

g. All fire rated ducts for Smoke Extract Duct shall have Stability / Integrity and Insulation for smoke temperatures up to 300°C up to 1.5 hrs, restriction of the duct due to twisting or buckling after the fire test shall not cause 25% or more reduction in cross-sectional area proven by certification from an independent test house.

•

h. Each duct shall have fire rated coating. Fire rated coating compound used for construction of fire rated ductwork shall be protected with minimum 0.7mm to 1mm nominal thickness tested to properties as per the requirements of BS 476: 6 & 7, including non-combustibility Class O and fire propagation - Class 1 surface spread of flame & materials in accordance with Building Regulations.

•

i. Fire duct to be tested / assessed to BS476: Part 24 for all sizes up to 25 meters x 3 meters cross-sectional area and fully certified to vertical and horizontal plane.

•

j. Fire rated duct fabricated to Method 3 of BS 5588: Part 9, factory produced. The coating compound shall be applied either offsite or onsite on the ground, dried and cured.

•

k. Fire duct expansion under fire conditions shall not exceed following,
- at 430°C an expansion of 0.006106mm per mm
- at 600°C an expansion of 0.00852mm per mm
- at 1100°C an expansion of 0.01562mm per mm.

15.8 BRAIDED (WIRE) ROPE SUPPORT

Braided (Wire) Hangers shall be used to suspend all static mechanical, electrical and HVAC services.

Braided (Wire) Rope Hangers shall consist of a pre-formed wire rope sling with either a ferruled loop, permanently fixed threaded M8 stud, or permanently fixed nipple end with toggle, at one end or hook or eyelet or any other end fixture type or size as per manufacturers recommendation. The end fixings and the wire must be of the same manufacturer. The system is secured and tensioned with a wire rope Hanger self-locking grip at the other end.

Only wire and/or supports supplied and/or approved, shall be used with the system.

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a. Braided (Wire) Rope Hangers have been independently tested by Lloyds Register. APAVE, TUV, UL, CSA and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope is manufactured to BSEN 12385: 2002.

b. The contractor shall select the correct specification of wire Hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit.

The correct specification of Braided (Wire) Rope Hanger required is determined using the following formula.

**Weight per meter of object suspended (kg) × distance between suspension points (m) = weight loading per Braided (Wire) Rope Hanger suspension point (kg).**

The contractor shall select the correct length of Braided (Wire) Rope required to support the service. Lengths from 1-10m lengths. No in–line joints should be made in the rope.

**Table 1**

<table>
<thead>
<tr>
<th>Size</th>
<th>Minimum breaking load of Braided (Wire) Rope (kg)</th>
<th>Braided (Wire) Rope construction</th>
<th>Tensile strength (N/mm²)</th>
<th>Working load limit (kg/lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>80kg/176 lbs</td>
<td>7 x 7 (6/1)</td>
<td>1770</td>
<td>0-10 kg / 0-22 lbs</td>
</tr>
<tr>
<td>No. 2</td>
<td>260kg/572 lbs</td>
<td>7 x 7 (6/1)</td>
<td>1770</td>
<td>10-45 kg / 23-100 lbs</td>
</tr>
<tr>
<td>No. 3</td>
<td>580kg/1276 lbs</td>
<td>7 x 7 (6/1)</td>
<td>1770</td>
<td>45-90 kg / 101-200 lbs</td>
</tr>
<tr>
<td>No. 4</td>
<td>1500kg/3300 lbs</td>
<td>7 x 19 (12/6/1)</td>
<td>1770</td>
<td>90-225 kg / 210-495 lbs</td>
</tr>
<tr>
<td>No. 5</td>
<td>2160kg/4752 lbs</td>
<td>7 x 19 (12/6/1)</td>
<td>1770</td>
<td>225-325 kg / 496-715 lbs</td>
</tr>
</tbody>
</table>

The standard range of Braided (Wire) Rope Hanger Kits shall be used which contains galvanized high tensile steel wire rope, the minimum specification is as above and shall be manufactured to BS 302 (1987), BSEN12385.
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Ducting Supports: All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, as per below duct hanger details (Schedule-1) of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter.
All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

**Schedule I: Duct Hanger Schedule**

<table>
<thead>
<tr>
<th>Maximum Duct Size (mm)</th>
<th>Gauge</th>
<th>Supporting Angle size (MM)</th>
<th>Rod size (MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 751</td>
<td>26</td>
<td>25x25x6</td>
<td>8</td>
</tr>
<tr>
<td>751-1000</td>
<td>26</td>
<td>25x25x6</td>
<td>8</td>
</tr>
<tr>
<td>1001-1200</td>
<td>24</td>
<td>40x40x6</td>
<td>10</td>
</tr>
<tr>
<td>1201 - 1500</td>
<td>24</td>
<td>40x40x6</td>
<td>10</td>
</tr>
<tr>
<td>1501 - 1800</td>
<td>22</td>
<td>40x40x6</td>
<td>12</td>
</tr>
<tr>
<td>1801-2100</td>
<td>20</td>
<td>50x50x8</td>
<td>14</td>
</tr>
<tr>
<td>2101-2700</td>
<td>18</td>
<td>50x50x8</td>
<td>14</td>
</tr>
<tr>
<td>Above 2700</td>
<td>18</td>
<td>C-Channel</td>
<td></td>
</tr>
</tbody>
</table>

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor’s work in the building.

**Piping Supports:** Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services. Rigid support must also be used in conjunction with wire rope hangers with pipe work at each change of direction or connection. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. All supports of pipe shall be taken from structural slab/wall by means of fastener. Support piping in accordance with Schedule II at the end of this Section.

**Electrical Cable Tray/Raceway Supports:** Y-Fit solution shall be used to a maximum width of 500mm tray. For Tray over 500mm cradle support method or independent Gripple supports must be taken.
as appropriate based on load. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services. Any other Gripple solution can be used based on manufacturer’s recommendation on site conditions after prior approval.

Refer to manufacturers catalogue and installation guide for further technical information. **Comply with manufacturer’s load ratings and recommended installation procedures.**

15.9 **VAV TERMINAL BOXES**

15.9.1 **VAV Terminal Boxes - General**

All the VAV Terminals shall be Pressure Independent type with Direct Digital Controls to regulate the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level within acceptable noise criteria. A separation shall be made in Induction VAV Terminals and Standard VAV Terminals as detailed in the schedule.

The Induction VAV Terminals shall induce room air, without need of an assisting fan, and mix it with conditioned primary air, maintaining a near constant air volume to the room thus providing sufficient air movement necessary to maintain occupant comfort even in extreme load variations.

The VAV terminal shall have the controls, actuators and transformers, etc. pre-fitted, wired and calibrated at the factory and supplied with its appropriate digitally communicating thermostat. The supply of the VAV Terminals and the VAV controls, as well as the commissioning at the site, shall be done by the same specialist/local supplier.

VAV box shall be provided with terminal re-heater section if indicated in Schedule of Quantities.

15.9.2 **Construction of Standard Pressure Independent VAV Terminals**

The casing shall be a double wall construction made from galvanized sheet steel (non spiral). Casing Leakage Rate shall be according to class II, VDI 3803/DIN 24 194. The insulation thickness shall be 25
mm. and the insulation material shall be fully enclosed by the metal casing. VAV Terminals with insulation materials in direct contact with the air flow will not be accepted.

The VAV Terminals shall have a low leakage, sandwich construction damper blade with SBR gasket and a solid aluminum damper shaft (diameter 12 mm.) with self lubricating Nylon bearings. The leakage shall be less than 2% of the nominal flow at 750 Pa. inlet static pressure. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively.

For large air volumes, Rectangular VAV Terminals shall be provided. These Rectangular VAV Terminals shall have a multi-leaf opposed blade damper with aluminum, aerofoil blade construction, width 50 mm. and external linkage. The damper spindle shall be made of steel (10 mm. diameter), rotating in self lubricating Nylon bearings. The VAV Terminal shall have 30 mm. flange connections at the inlet and outlet of the terminal.

Each VAV Terminal, Circular or Rectangular shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 2x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

15.9.3 Construction of Induction VAV Terminals (Pressure Independent)

The casing shall be rectangular type made from galvanized sheet steel (thickness 1.25 mm.) with a circular inlet, two Induction openings at the sides of the terminal and a rectangular outlet. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively. The VAV Terminal shall have internal insulation (thickness 25 mm.), tested HF-1 (UL 94) flame test and erosion proof up to 50 m/s air velocity.

The terminals shall be fitted with a specially constructed jet-tronic damper to regulate the primary air flow between the scheduled minimum and maximum values. The same damper shall also generate and control the Induction effect through the acoustically lined induction chamber of the VAV Terminal. The damper shaft shall be solid aluminum (diameter 12 mm.), rotating in self lubricating Nylon bearings.
lubricating Nylon bearings. The damper shall permit proper operation of the terminal over a range of 20 to 100% of maximum flow without the requirement of special VAV diffusers or assisting fans.

The Induction VAV Terminal shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 2x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.
15.10 DOCUMENTATION & MEASUREMENTS FOR DUCTING

All ducts fabricated and installed should be accompanied and supported by proper documentation viz:

a) Bill of material/Packing list for every duct section supplied.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification.

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centerline measurements described herewith.

Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in a similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centerline distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.
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The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 5mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber/access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall NOT be separately measured nor paid for.

b. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

i. Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

ii. Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

iii. Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

iv. Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.
v. Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

vi. Kitchen Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipment. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

15.11 FLEXIBLE DUCT:

Insulated flexible duct should be UL 181 CLASS I AIR DUCT LISTED AND LABELLED WITH NFPA 90A & 90B AND SEAL OF AIR DIFFUSION COUNCIL with double lamination of tough polyester which encapsulates steel helix wire forms the air tight inner core, double layer core wrapped in a multiple thickness of fiberglass wool with R Value 4.2, Green guard certification of fiberglass wool must, Reinforced and sheathed in a rugged and durable tri directionally reinforced metalized polyester jacket.

Flexible duct connections should be made as per UL181 listing procedure with proper flexible right forming brace connection allowing right connections for flexible duct into energy efficient and Strapping the flexible duct connections with flexible duct strap ties.

15.12 TESTING AND BALANCING

8. After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection.

9. 10. The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less/excess than 5 percent in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.
16  **INSULATION**

- 16.1 **SCOPE**

The scope of this section comprises the supply and application of insulation conforming to these specifications.

- 16.2 **MATERIAL**

Thermal insulation material for Duct insulation shall be closed cell chemically cross linked polyethylene foam external thermal insulation on ducts with approved sample of AL faced/closed cell nitrile rubber insulation with anti-microbial properties with duct insulation with density 40-55 Kg/ Cum complete as per specifications.

- Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) & R value as mentioned in ECBC -2008 at mean temperature of 0 degree C as per EN ISO 8497.
- Moisture Diffusion Resistance Factor or ‘µ’ value of insulation material shall be minimum 7,000 without any external barrier as per EN 13469.
- The insulation material shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame and also passes Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire category.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer’s test certificate for thermal conductivity values, density, water vapour permeability, and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner’s site representative and gotten tested for thermal conductivity and density at Contractor’s cost. Adhesive used for sealing the insulation shall be non-flammable, vapor proof adhesive strictly as per manufacturer’s recommendations.

Ducting insulation thickness shall be as per table below.

<table>
<thead>
<tr>
<th>Ducting position</th>
<th>Thk.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA duct in RA path</td>
<td>19 mm</td>
</tr>
<tr>
<td>Ducted return air system</td>
<td>SA duct: 25mm Exposed RA duct: 19 mm</td>
</tr>
</tbody>
</table>

- 16.3 **DUCT ACOUSTIC LINING**

- Acoustic lining inside ducts using Non Fibrous fire retardant, OPEN CELL engineered high performance elastomeric nitrile rubber insulation of 160+/- 20 Kg/m3 density & thickness of 15mm, NRC 0.48 as per ASTM C 423/ISO 354 applied with Synthetic rubber based Adhesive preferably Low VOC & high strength characteristic (Initial portion of ducting and main plenum) as per specifications.
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16.4 ACoustic LINING OF MECHANICAL ROOMS

The walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with
32 mm thick acoustic lining as per BOQ.

Installation Procedure

The wall surface shall be cleaned and required surface preparation shall be done for applying adhesive. Rubber based contact adhesive recommended by the manufacturer shall be used. The foam sheets shall be cut to required size and a thin layer of adhesive shall be applied to both the surfaces; wall and i. When it is tack dry, it is should applied / stuck with enough pressure to the walls/ceiling. Minimum 5 fasteners with washer (of G.I Sheet 2.5 inch x 2.5 inch) / square meter, 4 at corners & 1 at center shall be put immediately after sticking with the help of adhesive. The length of the fastener should be minimum 75 mm.

16.5 DUCT INSULATION

External thermal insulation shall be provided as follows:

The thickness of nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubber sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber sheets shall be done with adjustable blade to make $90^0$ cut in thickness of nitrile rubber sheet. Hackshaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good
bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer.

16.6 PIPING INSULATION

Thermal insulation material for Duct & Pipe insulation shall be closed cell Elastomeric EPDM Rubber. The Thermal conductivity of the insulation material shall not exceed 0.038 W/m°K at an average temperature of 32°C. Density of the EPDM rubber shall be 40-60 Kg/m³. The product shall have temperature range of –57°C to 125°C. The insulation material shall be fire rated for Class 0 as per UL 94. The flammability and smoke density shall be 25/50 as per ASTM E 84, Water vapour diffusion resistance factor(µ) ≥ 7000. The water absorption (weight%) shall not exceed 5 as per ASTM D 1056. The insulation material should be free from Nitrosamine contents as per US FDA norms. It should be CFC free. It should not be corrosive to copper and stainless when tested as per DIN 1988. The material should not develop crack when tested for ozone resistance as per ASTM 1149. The % shrinkage (Heat Stability) should not exceed 6 when tested as per ASTM C 534(93°C, 7 days). No cracks should develop when exposed to UV (accelerated weathering resistance test cycle UVB-313 at 60°C/8h, CON at 50°C/4h) as per ASTM G 154-04. The resistance to microbiological growth shall be in accordance to UL 181 – and meet the acceptance criteria of resistance to fungal contamination as per ASTM G21.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer’s test certificate for thermal conductivity values, density, water vapour resistance factor, Nitrosamine content, Heat stability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner’s site representative and gotten tested for thermal conductivity and density at Contractor’s cost. Adhesive used for sealing the insulation shall be modified neoprene contact adhesive with minimum bond strength of 1.25 kg/m². It should have high water vapour resistance, good weathering properties and self-extinguishing once dried strictly as per manufacturer’s recommendations.

Note:
All chilled water pipes running in AHU Room and vertical shaft shall be insulated with EPDM and finally, finished with 26G aluminium cladding.

16.7 PROTECTIVE COATING OVER INSULATION

To provide mechanical strength and protection from damage all pipe / duct insulated with nitrile rubber shall be covered with thermal insulation protecting coating with alkali resistance glass fibre fabric of weight 200 GSM and 7 mil minimum thickness reinforcement. The coating non-volatile
content shall be as per guideline of ASTM 1644-01 and Water permanence (perms) as per guideline ASTM E-96. The coating flammability, surface burning characteristics shall be as per ASTM E-84 and UL 723.

Insulated pipes & ducts exposed to UV rays shall be covered with fibreglass fabric. Over fabric one coat of fire proof epoxy or acrylic compound shall be applied. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

16.8 PUMP INSULATION

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

16.9 SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer’s standards.

16.10 COLD WATER AND EXPANSION TANK INSULATION

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer’s standard.

16.11 UNDERDECK INSULATION
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Under deck insulation with non-fibrous, Fire retardant Class 1, Closed Cell, tri-dimensionally chemically cross linked polyethylene foam with 32mm thickness is an excellent heat and effective vapour barrier. Thermal conductivity should not exceed 0.0328 W/m°C at 23°C.

The material shall conform to BS 476 Part 7 Fire Characteristics and offer a Constant K Value.

16.12 SOUND ATTENUATORS (NITRILE RUBBER OPEN CELL FOAM)

Attenuators shall be installed in ducts in accordance with requirements of drawings and as included in Schedule of Quantities.

Noise levels within conditioned spaces shall be not greater than those set out in schedule below:

a. Noise Level Design Criteria

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Area</th>
<th>Acceptable Noise Levels (NC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Ball Room/Meeting Rooms</td>
<td>25-30</td>
</tr>
<tr>
<td>ii.</td>
<td>Restaurant / Staff Dining</td>
<td>40-45</td>
</tr>
<tr>
<td>iii.</td>
<td>Offices</td>
<td>30-35</td>
</tr>
<tr>
<td>iv.</td>
<td>Office Corridor</td>
<td>35-40</td>
</tr>
</tbody>
</table>

b. Attenuators shall be of steel construction with casings out of minimum 22 G galvanized steel. Acoustic fill shall be inert, non-hygroscopic, vermin proof, fibre glass of required density adequately protected against corrosion and covered with 26 gage perforated aluminum sheet. Attenuators shall be supplied complete with flanges.

c. Acoustic performance of the attenuators (net insertion loss) shall meet or exceed the values listed below:
16.1.1.1 OCTAVE BAND CENTRE FREQUENCY HZ

<table>
<thead>
<tr>
<th></th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1K</th>
<th>2K</th>
<th>4K</th>
<th>8K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion loss dB</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>900 mm long</td>
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d. The pressure drop values of the silencers shall be indicated for each duty.

e. Manufacturers shall submit a test certificate for acoustic and aerodynamic performance of the attenuators. Attenuators shall be tested in accordance with ACMA test methods/BS 4718 and insertion loss and self-generated noise for each octave band and pressure drop shall be stated in the schedule.

16.13 MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith.

a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and
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depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.
17 AUTOMATIC CONTROLS AND INSTRUMENTS

17.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of automatic controls and instruments conforming to these Specifications and in accordance with the requirements of Drawings and Schedule of Quantities.

17.2 TYPE

All automatic controls shall be electric controls as described in the various sections of these Specifications. All instruments shall be as described in the various sections of these Specifications.

17.3 AUTOMATIC CONTROLS

Automatic controls required for various types of machines have been described in the various sections of these specifications and shown on the Drawings. The individual safety controls and selected automatic controls, may be installed within the machines by the manufacturers before shipment. However, the following automatic controls, if not already installed on the machines, may be installed at site by the contractor, as indicated in Schedule of Quantities.

a. Two way or Three-way modulating valve for each air handling units shall be provided in chilled water line at each air handling unit as shown on the Drawings and included in Schedule of Quantities. Each valve shall be actuated by a space thermostat. Constant space condition shall be maintained by continuous proportional modulation of the chilled water through the coil. The valve shall be provided with spring return function so that it reverts to fully by pass position when fan is shut off. Valves for 2.5 to 5 cm pipe sizes shall be similar to Honeywell model V 5013A three-way mixing valve with two inlets and one outlet.

For pipe sizes larger than 5 cm, valves shall be similar to Honeywell Model V 5013 B three way mixing valve with two inlets and one outlet.

Motor shall be similar to Honeywell model M 944 A proportional modutrol motor. Motor shall be suitable for 24 volts supply and shall have a cover mounted 220/24 volts transformer factory-installed.

b. Two way or Three -way diverting Valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in Schedule of Quantities. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall be provided with spring return function so that it reverts to fully bypass position when fan is shut off.
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• Valve shall be similar to Honeywell two position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.

• c. Flow Switch shall be provided in condensing water outlet and chilled water outlet at each water chilling machine, and at each water-cooled condensing unit for refrigeration system in cold stores, as shown on Drawings and included in Schedule of Quantities. Flow switch shall prevent the compressor from starting unless the cooling water flow is established in condensing water lines, and chilled water flow is established in chilled water lines.

• d. Thermostat shall be electric, fixed differential cooling / heating type as specified herein, with sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes, as recommend by the manufacturer. The profiles, mounting arrangement and exact location of thermostats shall be approved at site. Requirement of thermostats shall be as shown on Drawings and included in Schedule of Quantities.
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• i. Proportional control thermostats for air conditioning application for actuating the two ways or three way modulating valve at each air handling unit, as shown on Drawings and included in Schedule of Quantities. Thermostat shall be similar to Honeywell model T921B/T92A or equivalent, line voltage cooling thermostat. Range shall be 56-84 degree F, differential shall be 3 degree F.

• ii. Proportionate type thermostat for air conditioning applications for modulation of two ways or three-way diverting valve at each fan coil unit as shown on Drawings and included in Schedule of Quantities.

• Thermostat shall be similar to Honeywell model T694A or T4039 cooling thermostat, for range 56-84 degree F, differential 3 degree F, with OFF-HI-MED-LO fan switch, temperature adjustment NORMAL-COOL setting. Switching off must break fan circuit.

• iii. Snap acting fixed differential heating thermostat for electric reheat applications for putting on/off power supply to electric reheat coil in air handling unit as shown on Drawings and included in Schedule of Quantities. Thermostat shall be similar to Honeywell; model T451A, two stage thermostat.

• iv. Safety thermostat for electric reheats application for cutting off power supply to tubular heaters in case air flow across tubular heater is not established. Thermostat shall be similar to Varma Trafag model MS 95R.

• e. Humidistat may be provided with air handling unit for areas which require constant indoor humidity or humidity control with reheat, as shown on Drawings and included in Schedule of Quantities. One humidistat shall activate the reheat coils in case the space humidity rises beyond the preset limit, another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistats shall also de-energize these devices when the desired humidity is reached.

• Humidistat shall be snap acting or modulating type as per the requirement, 20-80 percent relative humidity range with differential of 5 percent. Humidistat shall have removable knob to prevent tempering of set point.

• f. Airstat and Safety thermostat may be provided as shown on Drawings and included in Schedule of Quantities, within air handling units containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.
17.1.1.7  17.4  INSTRUMENTS

Instruments required for different types of machines have been described in the various sections of these Specifications and shown on the Drawings. Following instruments may be provided as per the requirements indicated in the Schedule of Quantities.

a. Thermometers: shall be dial type 80 mm dia or V form industrial type. Body shall be aluminium alloy, anodised gold-coloured surface. The casing shall be adjustable sideways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0°C to 60°C & +32°F to 150°F. Graduation of scale shall be 1° in both readings. Range of scales shall be 30-120 degree F (0-50 degree C) for air conditioning applications of cooling only. Quality has been included in Schedule of Quantities.

Thermometer shall be suitable for 15 mm connections. Thermometer for chilled water shall be with long stem, so that thermometer is removable without damaging the insulation. M S socket to be welded on pipes shall be provided with thermometer. Thermometers shall be installed on chilled water supply and return at each air handling unit, supply and return at each chiller and condenser as shown on the Drawings and included in Schedule of Quantities.
b. Pressure Gages : shall be 80 mm dia & casing made out of SS 304 installed on suction header and at discharge side of each pump, in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller and condenser, as shown on the Drawings and included in Schedule of Quantities. Suction side gage at pump suction header shall be compound gage with 80 mm dia, range 75 cm vacuum to 8 kg (30 inch vacuum to 150 psi) pressure. Discharge sides gage at pumps and at all other locations shall be 80 mm range 0-8 kg per sq. cm (0-150 psi) pressure. Gages shall be connected to the pipes by 6 mm diameter Stainless Steel Syphon tube through a ball valve, required for gage protection.

c. Room Thermometer : shall be dial type, wall-hung temperature indicator, of appropriate range for cold stores and deep freezers, in accordance with the requirements of Drawings and Schedule of Quantities.

d. Room RH Indicator : shall be dial type, wall hung, relative humidity indicator of appropriate range, for special areas, in accordance with the requirements of Drawings and Schedule of Quantities.

e. Electronic Thermometer : shall be electronically operated Digital Temperature Indicator in accordance with requirement of Drawings and as included in Schedule of Quantities. The display shall be 3-5 digit Liquid Crystal Display. The thermometer shall consist of fully solid state integrated circuit. The thermometer shall have front LED ‘on’ indication and automatic low battery indication. The resolution shall be 1° centigrade. Thermometer shall be complete with suitable electronic sensor to accurately sense the temperature with sensor housed in suitable air well/thermo well for air temperature/water temperature measurement. The thermometer shall be suitable for operation on 9V DC / 230V AC. The display unit shall be housed in attractive sheet metal cabinet with prominent display of conversion charts of °F & °C on front plate. Thermometer shall be complete with separable socket type interconnecting cables of 2 m length suitable for installation within a radius of 2 m of the thermo well or air sensing point. Electronic thermometer may be installed at chilled water supply and return at selected air handling units as shown on Drawings and included in Schedule of Quantities. Range of scale shall be 30 degree F - 120 degree F (0-50 degree C) for air conditioning application.

17.1.1.8
17.1.1.9  17.5 CALIBRATION AND TESTING

All automatic controls and instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and their accuracy shall be guaranteed by the manufacturer. All automatic controls and instruments shall be tested at site for accuracy and reliability before commissioning the installation.
18. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

18.1 GENERAL REQUIREMENTS

1.1 This specification covers complete variable frequency drives (Vedas) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

1.2 The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.

1.3 The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.

1.4 The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.

1.5 The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

1.6 The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

18.2 TECHNICAL REQUIREMENTS

18.2.1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. Vedas utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

18.2.2 VFD shall be installed within panel, suitable for operating conditions.
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18.2.3 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

18.2.4 The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

18.2.5 Vedas with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

18.2.6 All Vedas shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The Vedas shall comply with the emission and immunity requirements of IEC 61800-3: 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of Vedas shall include additional EMC filters if required to meet compliance to this requirement.

18.2.7 The Veda’s full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

18.2.8 The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.
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18.2.9 A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor’s speed and load to adjust the applied voltage to maximize energy savings.

18.2.10 The VFD must be able to produce full torque at low speed to operate direct driven fans.

18.2.11 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

18.2.12 An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

18.2.13 Galvanic isolation shall be provided between the Veda’s power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Vedas not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

18.2.14 VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. Vedas with fixed carrier frequency are not acceptable.

18.2.15 The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

18.3 PROTECTIVE FEATURES

18.3.1 A minimum of Class 20 I²t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
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18.3.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

18.3.3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

18.3.4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

18.3.5 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

18.3.6 If the temperature of the Veda’s heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD’s temperature becomes too high.

18.3.7 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

18.3.8 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

18.3.9 Protect from output switching : The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.

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18.3.10 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

18.3.11 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

18.4 INTERFACE FEATURES

18.4.1 Hand, Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

18.4.2 There shall be an “Info” key on the keypad. The Info key shall include “on-line” context sensitive assistance for programming and troubleshooting.

18.4.3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

18.4.4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

18.4.5 All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

18.4.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD’s keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
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18.4.7 Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.

18.4.8 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

18.4.9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

18.4.10 A three-feedback PID controller to control the speed of the VFD shall be standard.

18.4.11 This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common set point or to individual set points and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

18.4.12 The VFD shall be able to apply individual scaling to each feedback signal.

18.4.13 For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

18.4.14 The VFD’s PID controller shall be able to actively adjust its set point based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

18.4.15 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide set point reset.

18.4.16 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

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18.4.17 Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

18.4.18 Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set “sleep” level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD’s speed is being controlled by its PID controller, it shall be possible to program a “wake-up” feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

18.4.19 A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.

18.4.20 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in °C, return air temperature in °C, supply air temperature in °C, CO₂ concentration in ppm, pressure in bar, differential pressure in PSI etc.

18.4.21 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

18.4.22 Standard Control and Monitoring Inputs and Outputs

18.4.22.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

18.4.22.2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

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18.4.22.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

18.4.22.4 Each relay shall have an adjustable on delay / off delay time.

18.4.22.5 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

18.4.22.6 Each shall be independently selectable to be used with either an analog voltage or current signal.

18.4.22.7 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

18.4.22.8 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

18.4.22.9 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.

18.4.22.10 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

18.4.22.11 It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

18.4.22.12 It shall be possible to command all digital and analog output through the serial communication bus.

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18.4.23 Optional Control and Monitoring Inputs and Outputs

18.4.23.1 It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

18.4.23.2 These modules shall use rigid connectors to plug into the VFD’s control card.

18.4.23.3 The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

18.4.23.4 Modules may include such items as:

18.4.23.5 Additional digital outputs, including relay outputs

18.4.23.6 Additional digital inputs

18.4.23.7 Additional analog outputs

18.4.23.8 Additional analog inputs, including Ni or Pt temperature sensor inputs

18.4.23.9 It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

18.4.24 Standard programmable firefighter’s override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter’s override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
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18.4.25 A real-time clock shall be an integral part of the VFD.

18.4.25.1 It shall be possible to use this to display the current date and time on the VFD’s display.

18.4.25.2 Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

18.4.25.3 All VFD faults shall be time stamped to aid troubleshooting.

18.4.25.4 It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

18.4.25.5 The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

18.4.25.6 The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

18.4.25.7 The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

18.4.25.8 Comparators for comparing VFD analog values to programmed trigger values

18.4.25.9 Logic operators to combine up to three logic expressions using Boolean algebra

18.4.25.10 Delay timers

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18.4.26 The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

18.5 SERIAL COMMUNICATIONS

18.5.1 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

- Metasys N2
- Modbus RTU

18.5.2 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

18.5.3 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD’s control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

18.6 ADJUSTMENTS

18.6.1 The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
18.6.2 Four independent setups shall be provided.

18.6.3 Four preset speeds per setup shall be provided for a total of 16.

18.6.4 Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

18.7 OPTIONAL FEATURES

18.7.1 All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.
18.8 SERVICE CONDITIONS

18.8.1 Ambient temperature at full speed, full load operation with continuous drive rated output current:

18.8.2 -10 to 45°C for ratings upto 90 kW without derating

18.8.2 -10 to 40°C for ratings 110 kW and higher without derating

18.8.3 Relative Humidity : 0 to 95%, non-condensing.

18.8.4 Elevation : Up to 3,300 feet without derating.

18.8.5 AC line voltage variation : ± 10% of nominal with full output.

18.8.6 VFD Enclosure protection : IP 55, integral, with no additional cabinets.

18.8.7 Side Clearances : No side clearance shall be required for cooling.

18.8.8 All power and control wiring shall be done from the bottom.

18.8.9 All VFDs shall be plenum rated.

18.9 QUALITY ASSURANCE
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18.9.1 To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

18.9.2 All optional features shall be functionally tested at the factory for proper operation.
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19. QUALITY ASSURANCE, INSPECTION, TESTING AND COMMISSIONING

19.1 SCOPE

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of work.

i. Provide quality assurance program (QAP), works quality assurance program (WQAP), field quality assurance program (FQAP) and quality plan.

ii. Tests at manufacturer’s works.

iii. Perform site tests and commissioning.

19.2 SUBMITTALS

i. After award of work following information shall be submitted.

   a. Quality Assurance Program (QAP)
   b. Works Quality Assurance programme (WQAP)
   c. Field Quality Assurance Programme (FQAP)

ii. For inspection and testing, submit inspection and testing procedures, programme, record sheets applicable at each hold point.

iii. After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
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iv. For site installation and commissioning, submit installation methods or procedures, notification and procedures for precommission and commissioning.

v. After commissioning, submit site test records, as-built drawings, manufacturer’s operation maintenance manuals and list of recommended spares and tools.

19.3 QUALITY ASSURANCE CONCEPT AND CONTROL

i. Minimum requirements for establishing and implementing a quality assurance programme shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems, and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance, and safety.

ii. Acceptance of the Contractor’s quality assurance programme does not relieve the Contractor’s obligation to comply with the requirement of the contract document. If the programme is found to be ineffective, then the Owner’s site representative reserves the right to request for necessary revisions of the programme.

iii. The Contractor is required to produce readily identifiable documentary evidence covering the extent and details of both his own and his sub contractor’s quality assurances system as follows:

a. Quality Assurance Program (QAP)
b. Works Quality Assurance programme (WQAP)
c. Field Quality Assurance Programme (FQAP)
d. Quality Plan.

iv. These documents shall be prepared separately and submitted to the Owner’s site representative at the time of starting the work.
v. Quality Plan and Manual shall be prepared by the Contractor for all items and services to be supplied, after the contract has been placed, but before commencement of fabrication, and shall be subject to evaluation and acceptance by the Owner’s site representative before start of work.
19.4 QUALITY ASSURANCE MANUAL (QAM)

I. The QAM shall be a general comprehensive document outlining the Contractor’s basic organization, policies, and procedures. The information to be given in the QAM shall include but not limited to:

a. Quality Policy.

b. Quality Assurance Programmed

C. Organization Structure showing inters relationships.

d. Functional responsibilities and levels of authority.

e. Lines of communication.

f. Customer relations.

g. Laboratory Facilities.

19.5 WORKS QUALITY ASSURANCE PROGRAMME (WQAP)

I. The WQAP shall identify the Contractor’s Quality Assurance Programmed at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the programmed elements to be designed, developed, executed, and maintained by the Contractor for the purpose of ensuring that all supplies and services comply with this specifications.

II. The information to be given under this programme shall include but not limited to:

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b. Contract Review.

c. Design and Document Control.

d. Procurement Control.

e. Production Control.

F. Control on Sub-contractors.

g. In-process Quality Control and Traceability.

h. Inspection and Testing.

i. Control of Non-conformances.

j. Corrective Action.

k. Control of Inspection, Measuring and Test Equipment.

l. Handling, Storage, Packaging, and Delivery.

m. Records.
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n. Quality Audits.

o. After - Sales Servicing.
19.6 **FIELD QUALITY ASSURANCE PROGRAMME (FQAP)**

I. This programme shall identify the Contractor’s Quality Assurance Programme at site applicable throughout site construction, erection, and commissioning. It is the underlying philosophy that the quality built into the product at works shall be maintained throughout the construction and commissioning stages.

II. While, in principle, the FQAP shall include the items discussed in WQAP, it shall, however, be approached differently to take into account site conditions.

III. The FQAP shall include, but not limited to the following information:

   a. Organization and responsibility.

   b. Control of Drawings and Documentation.

   c. Product Checklist.

   d. Control and Traceability of Purchased materials and services.

   e. Receipt Inspection of materials at site.

   f. Material Storage Control.

   g. Inspection and Examination Procedures.

   h. Control of Painting and Insulation Works.
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i. Pre-commissioning.

j. Commissioning.

k. Control of Non-conformances.

l. Corrective Action.

m. Control of Inspection, Measuring and Test Equipment.

n. Records.

o. Completion Documents.

p. List of recommended spares and tools.

q. Personal Training.

r. Servicing during Defects Liability Period.

19.7 QUALITY PLAN

I. The contractor shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of Owner’s site representative in the inspection and test programmers.

II. The Quality Plan shall incorporate as appropriate:
a. Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.

b. The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the action required by the hold point is met, and the documentation required is generated.

c. The control documents associated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.

19.8 SITE QUALITY CONTROL SECTION

I. The Contractor’s Quality Control (Q.C.) section shall be headed by an experienced Quality Control Engineer. He shall be assisted by other supervisors. The section shall be an independent one, reporting to the contractor’s Site Manager only on administrative matters, but otherwise under full control by the Contractor’s Corporate Quality System Management.

II. The Contractor’s Q.C. Section shall liaise closely with the Owner’s site representative in charge of Quality Assurance/Quality Control, and to whom it shall give fullest cooperation. It is the underlying principle of this contract document that while the Contractor’s Q.C. Engineer implements the Contractor’s Quality Programme, the adequacy and effectiveness of that implementation shall be audited by the Owner’s site representative whose recommendations on improving or maintaining quality shall be acted upon promptly by the Contractor’s Q.C. Section.

19.9 INSPECTION AND TESTING

I. All equipment and components supplied may be subjected to inspection and tests by the Consultant/Owner’s site representative during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of
II. Tenderers shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the Owner’s site representative.

III. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.

IV. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the Owner’s site representative may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the Owner’s site representative, the contractor shall submit the item for further inspection and /or test.

V. The approval of the Owner’s site representative of inspection and/or test results shall not prejudice the right of the Owner’s site representative to reject an item of equipment if it does not comply with the contract document when erected, does not, or prove completely satisfactory in service.

VI. The Contractor shall be responsible for the timely transmission of the relevant and appropriate sections of the contract document to manufacturers and sub-contractors for the proper execution of all tests at their works as per contract specifications.

19.10 TESTS AT MANUFACTURER’S WORKS

I. All tests to be performed during manufacture, fabrication, and inspection shall be agreed with the Consultant/ Owner’s site representative prior to commencement of the work. The Contractor shall prepare the details of the schedule and submit these to the Consultant/ Owner’s site representative for approval. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are
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made available to the Consultant/Owner’s site representative who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections.
II. A minimum of twenty-one days’ notice of the readiness of equipment for test or inspection shall be provided to the Owner’s site representative by the Contractor (whether the tests are held at the Contractor’s or Sub-contractor’s works). The subject items should remain available for Owner’s site representative inspection and test up to a minimum 8 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments, and manpower shall be provided by the Contractor and sub-contractor to enable the Owner’s site representative to carry out the necessary inspection and testing of the Plant.

III. No plant shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the Owner’s site representative or approved for shipment, or alternatively inspection has been waived.

IV. Functional electrical, mechanical, and hydraulic tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Owner’s site representative in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed programmed of tests to be agreed.

V. The Consultant/Owner’s site representative reserves the right to visit the Manufacturer’s works at any reasonable time during fabrication of equipment and to familiarize him with the progress made and the quantity of the work to date.

VI. Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates, and correction and performance curves shall be supplied to the Owner’s site representative.

VII. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Owner’s site representative or not. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title.

VIII. When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the Contractor into volumes and bound in an approved from complete with
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index and four copies of each volume shall be supplied to Consultant/ Owner’s site representative.

IX. Stage wise inspection of equipment in factory in waived.

19.11 PERFORMANCE TESTS AT MANUFACTURER’S WOKS

I. All equipment may be subjected to routine performance tests at the Manufacturer’s Works in accordance with the relevant ANSI, ASME, ASTM, BIS standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.

II. Pumps, fans, compressor, and other rotating equipment shall be given full load tests, and run to 15% overspend for 5 minutes to check vibration. Main and auxiliary gear boxes shall be subjected to shock load tests and a six-hour endurance run at rated speed and maximum torque.

III. The Contractor shall submit single line diagrams including the layout of the Plant together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior approval of the Owner’s Site Representative.

IV. The performance test shall be conducted over the full operating range of the pump to a closed valve condition and a minimum of five measurement points covering the full range shall be taken. Curves indicating Quality vs. Head, Quantity vs. Power absorbed, and Quantity vs. Pump efficiency shall be provided. In addition a curve of the NPSH required vs. Quantity shall be provided except when the suction conditions do not require this test. Any proposal for the omission of this test shall be to the approval of the Consultant/ Owner’s site representative.

V. On completion of the tests the Contractor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.
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20. TESTING, ADJUSTING AND BALANCING

20.1 SCOPE

a. Testing, adjusting, and balancing of heating, ventilating and air-conditioning systems at site.

b. Testing, adjusting, and balancing of HVAC Hydroid system at site.

c. Testing, adjusting, and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:


SMACNA: Manual for the Balancing and Adjustment of air distribution System.

20.2 PERFORMANCE

a. Verify design conformity.

b. Establish fluid flow rates, volumes and operating pressures.

c. Take electrical power readings for each motor.

d. Establish operating sound and vibration levels.
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e. Adjust and balance to design parameters.

f. Record and report results as per the formats specified.

20.3 DEFINITIONS

a. Test : To determine quantitative performance of equipment.

b. Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)

c. Balance : To proportion within distribution system (submains, branches and terminals) in accordance with design quantities.

20.4 TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly followed in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the PMC about his readiness to conduct the TAB procedures in the format given in these specifications.

20.5 DESCRIPTION OF SYSTEM AND REQUIREMENTS

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

a. All supply, return and outside air systems.

b. All exhaust air systems.

c. All chilled water systems.

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d. All cooling tower (condenser) water systems.

e. Emergency purge systems.

20.6 AIR SYSTEMS

1. Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results:

a. Air-IN DB and WB temperature.

b. Air-OUT DB and WB temperature.

c. Dew point air leaving.

d. Sensible heat flow.

e. Latent heat flow.

f. Sensible heat factor.

g. Fan air volume.

h. Fan air outlet velocity.

i. Fan static pressure.

j. Fan power consumption.

k. Fan speed.
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II. Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

III. The Preparatory Work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals:

a. All outside air intake, return air and exhaust air dampers are in proper position.

b. All system volume dampers and fire dampers are in full open position.

c. All access doors are installed & are air tight.

d. Grilles are installed & dampers are fully open.

e. Provision and accessibility of usage of TAB instruments for traverse measurements are available.

f. All windows, doors are in position.

g. Duct system are of proper construction and are equipped with turning vanes and joints are sealed.

h. Test holes and plugs for ducting.
20.7 HYDRONIC SYSTEM BALANCING

I. The Hydronic system shall involve the checking and balancing of all water pumps, piping network (main & branches), the heat exchange equipment like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

II. The essential preparation work must be done by the HVAC contractor prior to actual testing, adjusting, and balancing of HVAC system and ensure following:

• Availability of co-ordinate drawings and approved submittals and system sketch with design water flows specified thereon.

• Hydroid system is free of leaks, is hydrostatically tested, and is thoroughly cleaned, flushed, and refilled.

• Hydroid system is vented.

III. The contractor shall confirm completion of the basic procedures and prepare check lists for readiness of system balance.

a. Check pumps operation for proper rotation and motor current drawn etc.

b. Confirm that provisions for TAB measurements (Temperature, pressure, and flow measurements) have been made.

c. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the present position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the PMC/Consultants for approval.

20.8 READINESS FOR COMMENCEMENT OF TAB

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Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

20.9 TAB INSTRUMENTS

I. Air Measuring Instruments

a. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.

b. For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8386/8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air volume readings.

c. Pitot tube.

d. Electronic Rotary Vane Anemometer TSI make or equivalent.

e. Accubalance Flow Measuring Hood TSI make or equivalent.

All above instruments shall have a valid certification from a reputed testing institution.
II. Hydronic Measuring Instruments

a. For measurement of water flow across balancing valves, instruments as provided by the manufacturer of the valves specific to the type of valves shall be needed. This shall include but not be limited to differential pressure manometers. Temperature shall be measured using electric thermometers from thermowells provided at strategic location by the HVAC contractor.

The water balancing shall be carried out being computer simulation program provided / certified by the balancing valve manufacturer.

III. Rotation Measuring Instrument

a. Electronic Digital Tachometer.

IV. Temperature & RH Measuring Instrument

a. TSI VelociCalc model 8386 / VelociCalc model 8345 or equivalent.

V. Electrical Measuring Devices

a. Clamp on Volt ammeter.

b. Continuity Meter.

VI. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, air handling unit and fan driven by a motor over 8 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the PMC.
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Sound level readings shall be taken at ten (8) locations in the building as selected by the PMC. The readings shall be taken on an Octave Band analyzer in a manner acceptable to him. The contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of PMC/Consultant.
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LIST OF APPROVED MAKES

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## Construction of Teaching Hospital for New Govt. Medical College at Balangir, Odisha

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<td>ACID AND ALKALI RESISTENT TILES</td>
<td>Kajaria, Nitco, Durato, Somany</td>
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<td>Terreal, NBK, Feveton</td>
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### CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT. MEDICAL COLLEGE AT BALANGIR, ODISHA

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<td>ALUMINIUMSTANDINGSEAM ROOFING</td>
<td>KALZIP/BEMO/SANKO/KINGSSPAN</td>
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<td>VALIFOAM/PRATIBHA/PDPROJECTS/</td>
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<td>FIRERATINGHARDWARE</td>
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### B ELECTRICAL

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<td>INVERTOR</td>
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### B ELECTRICAL/SYSTEM/PANELS

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<th>FUSES&amp;SWITCHFUSEUNIT</th>
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<td>METALCLAD SOCKET</td>
<td>SIEMENS/MDS/C&amp;S</td>
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<td>CHANGE OVERSWITCH</td>
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<td>CONTACTOR, TIMER, SINGLE PHASE PREVENTOR &amp; OVERLOAD RELAY</td>
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<td>AE/L&amp;T/RISHAB/SOCOMAC</td>
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<td>ROTARY SWITCHES</td>
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<td>LIGHTNING ARRESTER</td>
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<td>H.T. CABLE END TERMINATION</td>
<td>BIRLA3M/REYCHEM/FRONTEC</td>
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### D. CONDUITING & WIRING ACCESSORIES

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<td><strong>BATRAHENLAY/ KEI/POLYcab/SKYTone/BONTON</strong></td>
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<td>BATTERYCHARGER</td>
<td>KELTRON/NELCO/EXIDE/HBLNIFE</td>
</tr>
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<td>3</td>
<td>EARTHING(ALLTYPE)</td>
<td>MEM/NUTECHPRODUCTS/MAHAVIRINDUSTRIAL CORPORATION/PRANAVENERGY.</td>
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</table>

### DG/PANEL/TRANSFORMER

<p>| | | |</p>
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<tbody>
<tr>
<td>1</td>
<td>ALTERNATOR</td>
<td>STAMFORD/CATERPILLAR/KIRLOSKER/CROMPTON</td>
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<tr>
<td>2</td>
<td>ENGINE</td>
<td>CUMMINS/CATERPILLAR/KIRLOSKER</td>
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<td>3</td>
<td>HT Panels</td>
<td>SPCELECTROTECH/ADLEC/HAVELLS/C&amp;S/ABB</td>
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<td>4</td>
<td>TRANSFORMER</td>
<td>VOLTAMP/ABB/AREVA/KIRLOSKER/SUDHIR</td>
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<td>5</td>
<td>UNITISED/COMPACTSUB-STATION</td>
<td>ABB/SIEMENS/SCHNIEDER/SUDHIR</td>
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### PLUMBING SYSTEM

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<tbody>
<tr>
<td>1</td>
<td>VITREOUSCHINASANITARYWARE</td>
<td>ROCA,HINDWARE/PARRYWARE/SOMANY</td>
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<td>PLASTICW.C.SEATS&amp;COVERS</td>
<td>ROCA,HINDWARE/PARRYWARE/SOMANY</td>
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<td>3</td>
<td>C.P.FITTINGS</td>
<td>JAQUAR/KINGSTON/GROHE/KOHLAR</td>
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<td>4</td>
<td>AUTOMATICWATERTAPS, AUTOMATICURINALFLUSHING SYSTEM</td>
<td>JAQUAR/KINGSTON/GROHE/KOHLAR</td>
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<td>5</td>
<td>TOWELRING,TOWELROD,TOWEL RACK, COATHOOKETC.(304GRADE S.S.)</td>
<td>JAQUAR/KINGSTON/GROHE/KOHLAR</td>
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<tr>
<td>No.</td>
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<td>6</td>
<td>CHROMIUMPANTED/STAINLESS STEEL/POLYVENIELCHLORIDE GRATING</td>
<td>JAQUAR/KINGSTON/GROHE/KOHLAR</td>
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<td>STAINLESSSTEELSINK</td>
<td>JAINA/NEELKANT/KINGSTON</td>
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<td>8</td>
<td>SANDCASTIRONSPUN PIPE,CENTIFUGALLYCASTED&amp;S ASPERIS:3989</td>
<td>NECO/RAJIRONFOUNDRY/RIF/SKF</td>
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<td>CASTIRONPIPE,HORIZONTALLY/ VERTICALLYCASTED&amp;S ASPER IS:1729</td>
<td>NECO/RAJIRONFOUNDRY/RIF/SKF</td>
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<td>10</td>
<td>G.I.&amp;M.S.PIPEPART-IIS:1239UPTO 150 MMAND M.S. PIPEPART-IIS: 3589 ABOVE150MM</td>
<td>TATASTEEL(TUBE DIVISION)/JINDALPIPES LIMITED</td>
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<td>11</td>
<td>G.I. ANDM.S.FITTINGS</td>
<td>UNIQUE./ ZOLOTO/DRP</td>
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<td>12</td>
<td>UPVCPIPES&amp;FITTINGS</td>
<td>SUPREME/FINOLEXINDUSTRIES/AKG</td>
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<td>CPVCPIPES&amp;FITTINGS</td>
<td>SUPREME/AKG/FINOLEXINDUSTRIES</td>
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<td>14</td>
<td>HDPEPIPE&amp;FITTINGS</td>
<td>SUPREME/AKG/FINOLEXINDUSTRIES</td>
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<td>C.I.CLASSLAPIPES</td>
<td>KESORMASPUNPIPE&amp;FOUNDRIES,CALCUTTA/SUPERENTERPRISES/INDIANIRON&amp; CO.LTD. CALCUTTA.</td>
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<tr>
<td>16</td>
<td>R.C.C.PIPES</td>
<td>PRAGATICONCRETEUDYOG/K.K. SPUNPIPES/J.K. SPUNPIPES/SOOD&amp;SOOD</td>
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<tr>
<td>17</td>
<td>STONEWAREPIPES&amp;GULLYTRAP</td>
<td>DEVRAJANANDCERAMIC(P)LIMITED./PERFECT POTTERIJAHALPUR(MP)/BURNPOTTERIES, JABALPUR</td>
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<tr>
<td>18</td>
<td>FORGEDBRASSBALLVALVE</td>
<td>NVR/ RB/ZOLOTO</td>
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<tr>
<td>19</td>
<td>F.B.MULTIUTILITYCHECKVALVE</td>
<td>NVR/ RB/ZOLOTO</td>
</tr>
<tr>
<td>20</td>
<td>F.B.AIRVENT</td>
<td>NVR/ RB/ HONEYWELL/ ZOLOTO</td>
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<td>21</td>
<td>F.B.P.R.V.</td>
<td>NVR/ RB/ HONEYWELL/ZOLOTO</td>
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<td>22</td>
<td>FLOATVALVE</td>
<td>NVR/ LEADER/ZOLOTO</td>
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<tr>
<td>23</td>
<td>C.I.SLUICE VALVE</td>
<td>NVR/ KSB/KIRLOSKER/ZOLOTO</td>
</tr>
</tbody>
</table>

DDFCONSULTANTSPVT.LTD.
| 24 | C.I.BUTTERFLY          | NVR/ ADUCO/IV/ZOLOTO |
| 25 | C.I.NRVREFLUX         | NVR/ LEADER/SANT/ZOLOTO |
| 26 | C.I.DUALPLATE         | NVR/ LEADER/SANT/ZOLOTO |
| 27 | D.I.WAFERTYPECHECKVALVE | NVR/ LEADER/IV/ZOLOTO |
| 28 | C.I.YTYPE STRAINER    | NVR/ LEADER/ EMERALD |
| 29 | C.I.DOUBLEACTINGAIRVALVE | NVR/ LEADER/ KIRLOSKER |
| 30 | FOOTVALVE             | NVR/ ZOLOTO |
| 31 | RESTALLTYPEOFVALVE    | NVR/ IV/SANT/ZOLOTO |
| 32 | C.I.MANHOLESCOVER&G.I.GRATING | K.K.MANHOLE&GRATINGCO.PRIVATELIMITED/ BANGALIRONCOMPANYWESTBANGAL/SHINING ENGINEERINGWORKS(FOUNDRY)AGRA. |
| 33 | HANDDRIER(304GRADES.S.) | THEVEERATRADINGCOMPANY/KOPALENGG. CORPN.NEWDELHI/ ASKONENGINEERSBOMBAY |
| 34 | LIQUIDSOAPDISPENSER(304GRADE S.S.) | THEVEERATRADINGCOMPANY/ASKON ENGINEERSBOMBAY |
| 35 | STORAGETYPEWATERHEATER | VENUS/ RACOLD/CROMPTONOR |
| 36 | INSULATION            | THERMAFLEX, AEROFLEX, KFLEX |
| 37 | SOLAR HOTWATEREQUIPMENT | TATASOLAR/SOLAHART |
| 38 | ELECTRICALHOTWATERHEATER | VENUS/KINGSTON |
| 39 | PVC FOOTREST&SFRCCOVERS | KK MANHOLESOREQUIVALENT |
| 40 | PIPES                 | REHAU/POLOPLAST/WAVINAS |
| 41 | SSPIPES               | JINDAL/VEIGA/ALFA |

**K PUMPSAND EQUIPMENTS**

<p>| 1  | WATERTRANSFERPUMPS   | ARMSTRONG/GROUNDFOS/KIRLOSKAR/CROMPTON |
| 2  | IRRIGATIONPUMP       | ARMSTRONG/GROUNDFOS/KIRLOSKAR/CROMPTON |
| 3  | SUMPPUMP             | GROUNDFOS/KIRLOSKAR/CROMPTON/KSB |
| 4  | WATERLEVELINDICATOR  | ADVANCEOREQUIVALENT |</p>
<table>
<thead>
<tr>
<th></th>
<th>WATERLEVELCONTROLLER</th>
<th>ADVANCEOREQUIVALENT</th>
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### CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT. MEDICAL COLLEGE AT BALANGIR, ODISHA

<table>
<thead>
<tr>
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<th>ELECTRONICSENSINGPROBE</th>
<th>ADVANCEOREQUIVALENT</th>
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<tr>
<td>6</td>
<td>CHLORINATOR</td>
<td>ASIA LMI PVT LTD/TOSHNIWAL</td>
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<td>7</td>
<td>WATERMETER</td>
<td>CRESENT/KAYEE/KAPSTAN/ANANDASHI</td>
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<tr>
<td>8</td>
<td>SOUNDERPATTERNVALVEFORFILTERANDSOFTENER</td>
<td>LABLINE/AIP(AGRICULTUREANDINDUSTRIALPUMPS).</td>
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<td>9</td>
<td>PRESSUREGAUGE</td>
<td>FIEBIG/H.GURU</td>
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<td>10</td>
<td>ELECTRICALPANEL</td>
<td>SPELECTROTECH/ADLEC/HAVELLS/C&amp;S/ABB</td>
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<tr>
<td>11</td>
<td>NONRETURNVALVE(65MMDIA&amp;ABOVE)</td>
<td>KIRLOSKAR/LEADER/ZOLOTO/NVR</td>
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<tr>
<td>12</td>
<td>BUTTERFLYVALVE(LEVERTYPE)</td>
<td>AUDCO/ADVANCE/DANFOSS/ATAM/SANT/ZOLOTO/NVR</td>
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<tr>
<td>13</td>
<td>BUTTERFLYVALVE(GEARTYPE)</td>
<td>AUDCO/ADVANCE/NVR/DANFOSS/ATAM/SANT/ZOLOTO</td>
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<td>14</td>
<td>FILTERANDSOFTENER</td>
<td>THERMAX/WATCON/BHARTIYATECHNOCRAFT/MIGRANI</td>
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<td>15</td>
<td>MOTORIZEDVALVE</td>
<td>DANFOSS/HONEYWELL</td>
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<tr>
<td>16</td>
<td>VIBRATIONPAD</td>
<td>RESISTOFLEX/KANWALINDUSTRIES</td>
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<td>17</td>
<td>VIBRATIONELIMINATOR</td>
<td>RESISTOFLEX/KANWALINDUSTRIES</td>
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<td>18</td>
<td>STP/ETP/WTP</td>
<td>B.S.ENVIROTECH/THERMAX/CTECH/DEGRIMOUNT.</td>
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<td>19</td>
<td>FIREFIGHTINGSYSTEM</td>
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#### ELECTRICDRIVENMOTORAND PUMPS

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<th>ELECTRICDRIVENMOTORAND PUMPS</th>
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<tbody>
<tr>
<td>1</td>
<td>GRUNDFOS/MATHERPLATT/EBARA/WILO/EMU/DP</td>
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<td>2</td>
<td>GRUNDFOS/MATHERPLATT/EBARA/WILO/EMU/DP</td>
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#### DIESELENGINE

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<tr>
<td>3</td>
<td>KIRLOSKAR/ASHOK LEYLAND/CUMMINS</td>
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#### G.I. ANDM.S.PIPES

<table>
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<tr>
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<th>G.I. ANDM.S.PIPES</th>
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<tbody>
<tr>
<td>4</td>
<td>TATA/JINDALHISAR/PRAKASH</td>
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#### FIREHOSEPIPES/RR.L.HOSEPIPE WITHCOUPLING (GUNMETAL/BRASS/SS)

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<th>FIREHOSEPIPES/RR.L.HOSEPIPE WITHCOUPLING (GUNMETAL/BRASS/SS)</th>
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<tr>
<td>5</td>
<td>NEWAGE/ MINMAX/EXFLAME</td>
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**DDFCONSULTANTSPVT.LTD.**
<table>
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<tr>
<th>No.</th>
<th>Description</th>
<th>Brand/Supplier</th>
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<tbody>
<tr>
<td>6</td>
<td>First Aid Fire Hose Reel with Bracket, Drum and Shut off Nozzle</td>
<td>NEWAGE/ MINMAX/EXFLAME</td>
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<td>7</td>
<td>G.I. ANDM.S. Fittings</td>
<td>KS/UNIK/DRP/ZOLOTO/NVR</td>
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<tr>
<td>8</td>
<td>C.I. Double Flanged sluice/Gate Valve/Non-Return Valves</td>
<td>ZOLOTO/KIRLOSKAR/SANT/LEADER/NVR</td>
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<td>9</td>
<td>Slimseal Butterfly Valves (PN-1.6)</td>
<td>ZOLOTO/KIRLOSKAR/SANT/LEADER/NVR</td>
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<tr>
<td>10</td>
<td>C.I. Body Butterfly Valve</td>
<td>ZOLOTO/KIRLOSKAR/SANT/LEADER/NVR</td>
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<td>11</td>
<td>Gunmetal Body Butterfly Valve</td>
<td>ZOLOTO/KIRLOSKAR/SANT/LEADER/NVR</td>
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<td>12</td>
<td>Landing Valve (Gunmetal/Brass/SS/Aluminium)</td>
<td>NEWAGE/ MINMAX/EXFLAME</td>
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<td>13</td>
<td>Alarm Gong</td>
<td>HD OREQUIVALENT</td>
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<td>14</td>
<td>QB Sprinkler</td>
<td>TYCO/GRINNEL/ KIDDE/CENTRAL/GTECH</td>
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<td>15</td>
<td>Wrapping and Coating</td>
<td>TYPECOAT/RUSTECH/COALTEK</td>
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<td>Fabricated Fire Hose Cabinet</td>
<td>STEELAGE/ NEWAGE/G.TECH</td>
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<td>Branch Pipe/Nozzles (Gunmetal/Brass/SS/Aluminium)</td>
<td>MINMAX/NEWAGE/ EXFLAME</td>
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<td>Fire Extinguishers (All Type)</td>
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<td>Fireman Axe</td>
<td>NEWAGE/ MINMAX/EXFLAME</td>
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<td>Fire Brigade Connection</td>
<td>NEWAGE/MINMAX/G.TECH/SUPEREX</td>
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<td>21</td>
<td>Suction Strainer</td>
<td>JATPEE/ GRANDPRIT/DASHMESH</td>
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<td>22</td>
<td>Vibration Eliminator Connectors</td>
<td>RESISTOFLEX/KHANWAL/D. WREN</td>
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<td>23</td>
<td>Single Phasing Preventor (Current Operated)</td>
<td>L &amp;T/ SIEMENS/MINILEC</td>
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<td>24</td>
<td>Flowmeter</td>
<td>SCIENTIFIC EQUIPMENT (P) LTD. SHALIBANDA HYDERABAD–500263</td>
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<td>25</td>
<td>Electrical Switchgear &amp; Starters</td>
<td>Siemens/L&amp;T/ABB</td>
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<td>26</td>
<td>Cables</td>
<td>BatraHENLAY/KEI/POLYcab/ Skytone/Havells</td>
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<td>27</td>
<td>Flowswitch</td>
<td>Potter/SystemSensor/JhonsonControl</td>
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<td>Main Control Panel (Powder Coated)</td>
<td>SpceElectrotech/ADLEC/Havells/C&amp;S/ABB</td>
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<td>29</td>
<td>Pressure Switches</td>
<td>Indfoss/Switzer</td>
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<td>Pressure Gauge</td>
<td>H.Guru/Fiebig</td>
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<td>Battery</td>
<td>Exide/Prestolite</td>
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<td>Paint Name of Pipes etc.</td>
<td>J&amp;N/Asian/Nerolac/Berger</td>
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<tr>
<td>33</td>
<td>Annunciator Panel for Sprinkler System</td>
<td>PCD/SafeWay/ Agni(India)</td>
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<td>34</td>
<td>Alarm Valve &amp; Hydraulic Alarm Motor with Covering</td>
<td>Mather&amp;Platt/HD</td>
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<td>35</td>
<td>Contactor</td>
<td>L&amp;T/Siemens/Schneider/GE/ABB</td>
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<td>36</td>
<td>Thimbles/Ferrules (Tinned Copper)</td>
<td>Dowelorequivalent</td>
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<td>Cable Glands</td>
<td>Commex/ Power/Gripwell</td>
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<td>Power Capacitor</td>
<td>L&amp;T/Crompton/Asian/Ducatti</td>
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<td>Measuring Meter (Digital)</td>
<td>L&amp;T/Siemens/AE/Enerecon</td>
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<td>Dash Fastener</td>
<td>Hilti/Fisher/Trixel</td>
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<td>Paint Primers</td>
<td>Asian/JensonNicholson</td>
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<td>Welding Electrodes</td>
<td>Advani/Esab/Victor</td>
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<td>43</td>
<td>Pipe Hangers</td>
<td>Chilly/GmGr</td>
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<td>MCB, DBS</td>
<td>MDS/LeGrand/SpceElectrotech</td>
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<td>2-Way Inlet Breaching</td>
<td>Newage/ Minmax/Exflame</td>
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<td>4-Way Inlet Breaching</td>
<td>Newage/ Minmax/Exflame</td>
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## HVAC WORKS

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<tr>
<td>1</td>
<td>ROTARY SCREW WATER-COOLED WATER CHILLING MACHINE WITH VSD (ARI CERTIFIED)</td>
<td>JHONSON/ TRANE/ CARRIER/ DAIKIN/VOLTAS</td>
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<tr>
<td>2</td>
<td>PUMPSETS (FOR PRIMARY/ SECONDARY CHW PUMPS &amp; CONDENSER WATER PUMPS)</td>
<td>ITT-XYLEM/ ARMSTRONG/ GRUNDFOSS</td>
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<td>3</td>
<td>VARIABLE SPEED PUMPING STEM.</td>
<td>ITT- XYLEM/ ARMSTRONG/ GRUNDFOSS</td>
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<td>4</td>
<td>VARIABLE FREQUENCY DRIVE (FOR PUMPS, COOLING TOWER &amp; AHU)</td>
<td>DANFOSS (FC102)/ ABB (ACH550) / SIEMENS (SINAMICSG120P)</td>
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<td>5</td>
<td>PRESSURIZED EXPANSION TANK FOR CHILLEDF WATER &amp; HOT WATER CIRCUIT</td>
<td>FLAMCO/ EMERALD/ KDAGENCY / SPIROTECH</td>
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<td>6</td>
<td>AIR &amp; DIRT SEPARATOR, VACUUM DEGASSER</td>
<td>FLAMCO/ SPIROTECH</td>
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<td>7</td>
<td>COOLING TOWER</td>
<td>DELTA/BELL/ PAHARPUR</td>
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<td>8</td>
<td>HOT WATER GENERATOR &amp; ULTRASONIC HUMIDIFIER</td>
<td>KEPL/ EMERALD/ RAPIDCOOL</td>
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<td>9</td>
<td>ELECTROCHEMICAL WATER TREATMENT &amp; DISINFECTION SYSTEM (FOR AC PLANT)</td>
<td>ELGRESSY/ TERRAGON/ ENPARTECHNOLOGIES</td>
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<td>10</td>
<td>AIR HANDLERS UNIT</td>
<td>EDGETECH/ZECO/ WAVES/ VTS</td>
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<td>11</td>
<td>HEAT ENERGY RECOVERY WHEEL</td>
<td>DRI/ NOVELAIR- SEVCON/ OSTBERG</td>
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<td>FAN COIL UNIT WITH HAMCA CERTIFIED FAN FOR SOUND &amp; PERFORMANCE</td>
<td>EDGETECH/ZECO/ WAVES/ VTS</td>
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<td>13</td>
<td>ARICERTIFIED COOLING/ HEATING COIL (AHU &amp; FCU)</td>
<td>EDGETECH/ZECO/ WAVES/ VTS</td>
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<td>AHU FANS (AMC CERTIFIED FOR SOUND &amp; PERFORMANCE) PLUG FAN/ DIDW CENTRIFUGAL F ORWARD</td>
<td>KRUGGER/ AIRFLOW/ SYSTEM</td>
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<td>Brand/Model</td>
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<td>Edgetech/Zeco/Waves</td>
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<td>16</td>
<td>Scrubber &amp; Air Washer Fans</td>
<td>Krugger/Airflow/SystemsAir</td>
</tr>
<tr>
<td>17</td>
<td>Acoustically Insulated Inline Box Fans</td>
<td>Krugger/Airflow/SystemsAir</td>
</tr>
<tr>
<td>18</td>
<td>Axial Fan / Centrifugal Fan for Ventilation</td>
<td>Airflow/SystemsAir/Comefri</td>
</tr>
<tr>
<td>19</td>
<td>Three Phase Motors</td>
<td>ABB/CG/Siemens/Marathon</td>
</tr>
<tr>
<td>20</td>
<td>Three Phase Motors (250°C for 2 hours)</td>
<td>Marathon/Havells-Lafert/Baldor</td>
</tr>
<tr>
<td>21</td>
<td>Water Piping</td>
<td>Tata/SAIL/Jindal</td>
</tr>
<tr>
<td>22</td>
<td>Y-Strainer/Pot-Strainer</td>
<td>Emerald/RapidCool</td>
</tr>
<tr>
<td>23</td>
<td>Butterfly Valve</td>
<td>Advance/Audco/Zoloto</td>
</tr>
<tr>
<td>24</td>
<td>Dual Plate Check Valve</td>
<td>Advance/Larzentoubro/Zoloto</td>
</tr>
<tr>
<td>25</td>
<td>Automatic Balancing Valves</td>
<td>Danfoss/Flowcon/Siemens/Advance-Pettinarolli/Zoloto</td>
</tr>
<tr>
<td>26</td>
<td>Pressure Independent Balancing Cum 2-Way Modulating Control Valve</td>
<td>Danfoss/Flowcon/Siemens/Advance-Pettinarolli</td>
</tr>
<tr>
<td>27</td>
<td>Globe/Ball Valve (With or Without Strainer)</td>
<td>Leader/Betaflo/Sant/Zoloto</td>
</tr>
<tr>
<td>28</td>
<td>Auto Air Vent Valve</td>
<td>Spirotech/Comfort/Airtech/Zoloto</td>
</tr>
<tr>
<td>29</td>
<td>Industrial Type Thermometer</td>
<td>Emerald/Guru/Fiebig</td>
</tr>
</tbody>
</table>
### Construction of Teaching Hospital for New Govt. Medical College at Balangir, Odisha

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.</td>
<td>GSSSHEET</td>
</tr>
<tr>
<td>31.</td>
<td>ALUMINIUMSHEET</td>
</tr>
<tr>
<td>32.</td>
<td>FACTORYFABRICATEDDUCT</td>
</tr>
<tr>
<td>33.</td>
<td>INSULATEDFLEXIBLEDUCT</td>
</tr>
<tr>
<td>34.</td>
<td>DUCT/ PIPESUPPORT</td>
</tr>
<tr>
<td>35.</td>
<td>FIRE&amp;SMOKEDAMPERSPRINGTYPE</td>
</tr>
<tr>
<td>36.</td>
<td>FIREDAMPERACTUATOR</td>
</tr>
<tr>
<td>37.</td>
<td>EXTRUDEDALUMINUMGRILLS/ DIFFUSERS</td>
</tr>
<tr>
<td>38.</td>
<td>VARIABLEAIRQUANTITY/INDOOR AIRQUANTITY UNIT(WIRELESS)VAQ/IAQ</td>
</tr>
<tr>
<td>39.</td>
<td>CAVUNIT</td>
</tr>
<tr>
<td>40.</td>
<td>FILTERS</td>
</tr>
<tr>
<td>41.</td>
<td>VIBRATIONISOLATIONSPRING&amp; FLEXIBLEPIPECONNECTOR</td>
</tr>
<tr>
<td>42.</td>
<td>CLOSEDCELLFIRERETARDANTXPE (FORDUCTINSULATION)</td>
</tr>
<tr>
<td>43.</td>
<td>NITRILERUBBERINSULATION(FOR PIPEINSULATION)</td>
</tr>
<tr>
<td>44.</td>
<td>EXPANDEDPOLYSTYRENE</td>
</tr>
<tr>
<td>45.</td>
<td>FIBRE GLASSRIGID BOARD</td>
</tr>
<tr>
<td>46.</td>
<td>PAINTS</td>
</tr>
<tr>
<td>47.</td>
<td>TAFELT/CPRXCOMPOUND</td>
</tr>
<tr>
<td>48.</td>
<td>DASHFASTENERS</td>
</tr>
<tr>
<td>49.</td>
<td>WELDINGRODS</td>
</tr>
<tr>
<td></td>
<td>Item Description</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>50.</td>
<td>Copper Refrigerant Piping</td>
</tr>
<tr>
<td>51.</td>
<td>Electrical Panel, Console Panel &amp; Ahusub-Panels</td>
</tr>
<tr>
<td>52.</td>
<td>Air-Circuit Breaker</td>
</tr>
<tr>
<td>53.</td>
<td>M.C.C.B.</td>
</tr>
<tr>
<td>54.</td>
<td>MCB</td>
</tr>
<tr>
<td>55.</td>
<td>Starters, Contactors, Push Buttons, Overload Relay</td>
</tr>
<tr>
<td>56.</td>
<td>Single Phase Preventer</td>
</tr>
<tr>
<td>58.</td>
<td>Rotary Switches</td>
</tr>
<tr>
<td>59.</td>
<td>Selector &amp; Toggles Switch</td>
</tr>
<tr>
<td>60.</td>
<td>Changeover Switch</td>
</tr>
<tr>
<td>61.</td>
<td>Hrc Fuse And Fittings</td>
</tr>
<tr>
<td>62.</td>
<td>Voltmeter/Ammeter</td>
</tr>
<tr>
<td>63.</td>
<td>Indicating Lamps</td>
</tr>
<tr>
<td>64.</td>
<td>Time Delay Device</td>
</tr>
<tr>
<td>65.</td>
<td>Power Cable &amp; Accessories</td>
</tr>
<tr>
<td>66.</td>
<td>Control Cable &amp; Accessories</td>
</tr>
<tr>
<td>67.</td>
<td>M Conduit With Accessories/GI Conduit (ISI Marked)</td>
</tr>
<tr>
<td>68.</td>
<td>TdRS</td>
</tr>
<tr>
<td>70.</td>
<td>Raceways &amp; Cable Tray</td>
</tr>
</tbody>
</table>

**N. BMSS System**

A) Software: Honeywell/ALC/Siemens

B) Network Area Controller: Honeywell Trend/ALC/Siemens
<table>
<thead>
<tr>
<th></th>
<th>Component Description</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>THIRD PARTY INTEGRATOR</td>
<td>HONEYWELL TRENDS/ALC/SIEMENS</td>
</tr>
<tr>
<td>D</td>
<td>CENTRAL AND DDC CONTROLLERS</td>
<td>HONEYWELL TRENDS/ALC/SIEMENS</td>
</tr>
<tr>
<td>E</td>
<td>ULTRASONIC BLOOD METERS</td>
<td>FORBES MARSHALL/LANDIS &amp; GYR/SIEMENS</td>
</tr>
<tr>
<td>F</td>
<td>IMMERSION TEMPERATURE SENSOR</td>
<td>HONEYWELL/ELEKTRON/ALC/SIEMENS</td>
</tr>
<tr>
<td>G</td>
<td>RETURN AIR TEMPERATURE SENSOR</td>
<td>HONEYWELL/ELEKTRON/ALC/SIEMENS</td>
</tr>
<tr>
<td>H</td>
<td>NETWORK/REMOTE OPERATOR TERMINAL</td>
<td>HONEYWELL/ALC/SIEMENS</td>
</tr>
<tr>
<td>I</td>
<td>CO/CO₂ SENSOR</td>
<td>HONEYWELL/ELEKTRON/ MSA/SIEMENS</td>
</tr>
<tr>
<td>J</td>
<td>MOTORIZED BUTTERFLY VALVE</td>
<td>ADVANCE/AUDCO</td>
</tr>
<tr>
<td>K</td>
<td>TEMPERATURE PLUS RH SENSOR</td>
<td>HONEYWELL/ELEKTRON/CARRIERACE/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SIEMENS</td>
</tr>
<tr>
<td>L</td>
<td>DIFFERENTIAL PRESSURE SWITCH AIR</td>
<td>HONEYWELL/SIEMENS/ BECK</td>
</tr>
<tr>
<td>M</td>
<td>DIFFERENTIAL PRESSURE SWITCH WATER</td>
<td>HONEYWELL/CARRIERACE/ SIEMENS</td>
</tr>
<tr>
<td>N</td>
<td>COMPUTER</td>
<td>IBM/COMPAQ/HP/DELL</td>
</tr>
<tr>
<td>P</td>
<td>COMMUNICATION CABLE</td>
<td>DELTON/FUSIONPOLYMER/SKYTONE</td>
</tr>
<tr>
<td>Q</td>
<td>DIGITAL THERMOSTAT/HUMIDISTAT</td>
<td>SIEMENS/HONEYWELL/ CARRIERACE</td>
</tr>
<tr>
<td>72</td>
<td>CERTIFIED AHU VC/COIL TRON &amp; DUCT MOUNTED/UVGI</td>
<td>RUKS/STERIL-AIRE/TRIMMED</td>
</tr>
<tr>
<td>73</td>
<td>AIR COOLED HI WALLS SPLIT UNIT</td>
<td>HITACHI/BLUESTAR/VOLTA/CARRIER/DAIKIN/TOSHIBA/GENERAL/MITSHUBISHI</td>
</tr>
<tr>
<td>74</td>
<td>AIR COOLED PRECISION A UNIT</td>
<td>EMERSON/APC/STULZ/BLUEBOX</td>
</tr>
<tr>
<td>75</td>
<td>ANY MISSING ITEM</td>
<td>PRIOR PERMISSION FROM HVAC CONSULTANT IS REQUIRED.</td>
</tr>
</tbody>
</table>
**OTHER EQUIPMENTS**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><strong>CSSD (CENTRAL STERILE SUPPLY DEPARTMENT)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><strong>HORIZONTAL RECTANGULAR HIGH PRESSURE HIGH VACUUM DOOR STERILIZER.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>2</td>
<td><strong>STAINLESS STEEL 316 CARRIAGES SUITABLE FOR RECTANGULAR STERILIZER.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>3</td>
<td><strong>STAINLESS STEEL 304 TROLLEYS SUITABLE FOR ABOVE CARRIAGE.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>4</td>
<td><strong>S.S. CONTROL AND PACKING TABLE WITH DRAWER.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>5</td>
<td><strong>STAINLESS STEEL WORK TABLE.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>6</td>
<td><strong>S.S. VERTICAL SLIDING DOOR.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>7</td>
<td><strong>STAINLESS STEEL WORK TABLE WITH TWO SINK.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>8</td>
<td><strong>WASHER DISINFECTOR (CAPACITY OF 275 LTRS.).</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>9</td>
<td><strong>ULTRASONIC CLEANER.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>10</td>
<td><strong>DRYING CABINET WITH SINGLE DOOR.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>11</td>
<td><strong>STAINLESS STEEL RACK WITH 5 SHELVES, ALL SIDES OPEN AND STAINLESS STEEL BULLET FEET. OVERALL SIZE 1830X535X1830MM.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>12</td>
<td><strong>STAINLESS STEEL TABLE TROLLEY WITH 2 SHELVES.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>13</td>
<td><strong>GAUZE CUTTING MACHINE WITH SS TABLE SIZE 900X600X750MM.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>14</td>
<td><strong>SINGLEDISTILLEDWATERSTILL.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>15</td>
<td><strong>STAINLESS STORAGETANK, ELECTRIC LOAD 6 KW. CAPACITY 100 LITRES.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>16</td>
<td><strong>SPRAYGUN RINSE.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>17</td>
<td><strong>BARCODEREADER</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>18</td>
<td><strong>HEAT SEALING MACHINE</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
<tr>
<td>19</td>
<td><strong>GLOVE PROCESSING EQUIPMENT CONSISTING OF WASHER, DRYER, POWDERER, TESTER AND EXAMINER AND GLOVES SORT BINS.</strong></td>
<td>YORCO, STERI, NAT STEEL, LSR</td>
</tr>
</tbody>
</table>
## CONSTRUCTION OF TEACHING HOSPITAL FOR NEW GOVT. MEDICAL COLLEGE AT BALANGIR, ODISHA

### B: TISSUE EQUIPMENTS

<table>
<thead>
<tr>
<th>No.</th>
<th>Item Description</th>
<th>Supplier Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Sterilized Single Free Standing Basket Rack (Storing of 8 Insingle Basket Racks)</td>
<td>Yorco, Steri, Natsteel, LSR</td>
</tr>
<tr>
<td>21</td>
<td>Sterilized Single Free Standing Basket Rack (Storing of 16 Indouble Basket Racks)</td>
<td>Yorco, Steri, Natsteel, LSR</td>
</tr>
<tr>
<td>22</td>
<td>Sterilized DSS Wire Basket (Full Size)</td>
<td>Yorco, Steri, Natsteel, LSR</td>
</tr>
<tr>
<td>23</td>
<td>Sterilized DSS Wire Basket (Half Size)</td>
<td>Yorco, Steri, Natsteel, LSR</td>
</tr>
<tr>
<td>24</td>
<td>ETO</td>
<td>Yorco, Steri, Natsteel, LSR</td>
</tr>
</tbody>
</table>

### C. LAUNDRY EQUIPMENTS

<table>
<thead>
<tr>
<th>No.</th>
<th>Item Description</th>
<th>Supplier Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Industrial Washer Extractor (60 Kg. Capacity)</td>
<td>Stefab/Girbau/Primer/Natsteel/Fabcare</td>
</tr>
<tr>
<td>3</td>
<td>Industrial Washer Extractor (30 Kg. Capacity)</td>
<td>Stefab/Girbau/Primer/Natsteel/Fabcare</td>
</tr>
<tr>
<td>4</td>
<td>Industrial Drying Tumbler (60 Kg. Capacity)</td>
<td>Stefab/Girbau/Primer/Natsteel/Fabcare</td>
</tr>
<tr>
<td>5</td>
<td>Industrial Drying Tumbler (30 Kg. Capacity)</td>
<td>Stefab/Girbau/Primer/Natsteel/Fabcare</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Manufacturer/Supplier</td>
</tr>
<tr>
<td>---</td>
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<td>-----------------------</td>
</tr>
<tr>
<td>6</td>
<td>FLATWORK DRYING IRONER (ROLLER SIZE: Ø530X3000 L)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>7</td>
<td>FLATBED DRYING PRESS (HEAD SIZE: 1500X750)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>8</td>
<td>VACUUM FINISHING TABLE (TABLETOP SIZE: 1200X750)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>9</td>
<td>AIR COMPRESSORS - 2 HP, SINGLE STAGE</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>10</td>
<td>DRY LINEN TROLLEY, 50 KG CAPACITY, - (850X650X1680)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>11</td>
<td>WASH LINEN TROLLEY, 50 KG CAPACITY, - (850X650X800)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>12</td>
<td>SHELF TROLLEY, 100 KG CAPACITY, - (850X650X1680)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>13</td>
<td>MOBILE TABLE, -(1130X720X800)</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
<tr>
<td>14</td>
<td>LAUNDRY SCRUB STATION WITH 2 SINKS</td>
<td>STEFAB/GIRBAU/PRIMER/NATSTEEL/FABCARE</td>
</tr>
</tbody>
</table>

**Note:** Contractors have to take approval from Engineer in charge/Consultants before placing order of any required materials from the above-specified approved makes. If any required materials (as per BOQ/Extra items) not available in the above list, Engineer in charge/Consultants can add them in the list at any stage, decision will be final and binding on contractors. If any doubt about listed makes/Brand Engineer in charge may amend the list at any stage, decision will be final and binding on contractors.