TENDER DOCUMENT

TENDER No.: DLI/C&E/731/002

FOR

Tender for the “Construction of Medical College and Hospital at Sundergarh Odisha”.

VOLUME – II

(Additional Conditions of Conditions (ACC), Technical Specifications, Tender Drawing)

ENGINEERING PROJECTS (INDIA) LIMITED
(A GOVT. OF INDIA ENTERPRISE)
Core-3, SCOPE Complex,
7, Lodhi Road, New Delhi – 110003
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Additional Conditions of Conditions (ACC)</td>
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<td>2.</td>
<td>Technical Specification</td>
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<tr>
<td>3.</td>
<td>Tender Drawing</td>
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## DRAFT

### ADDITIONAL CONDITIONS OF CONTRACT (ACC)

<table>
<thead>
<tr>
<th>1.</th>
<th>General</th>
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<tr>
<td>The Additional Conditions shall be read in conjunction with General Conditions of Contract. Where the provision of these Additional Conditions are at variance with the provision of the General Conditions of Contract, the provisions of these Additional Conditions shall take precedence.</td>
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<th>2.</th>
<th>Scope of Work</th>
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<td>The scope of work of the contract shall be “Civil, Plumbing, Sanitary, Internal&amp; External Electrification, HAVC, Lifts and other allied works” (hereinafter referred to as “Works”) as per Technical specifications, Drawings, BOQ, Instructions and Terms and conditions given in Tender Documents.</td>
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<th>3.</th>
<th>Commencement and Completion of Project:</th>
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<tr>
<td>The Contractual Completion Period shall be 20 (Twenty) months from the 10\textsuperscript{th} day of issue of Letter of Intent of Acceptance of Tender.</td>
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<th>4.</th>
<th>Bidders Confirmation</th>
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<td>Bidder confirms that they have read and understood and have copies of the 'Tender Documents' and have visited the site and their offer will be based on the ‘tender Documents’ and caters to all the works, requirements, etc. thereof.</td>
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<th>5.</th>
<th>References: CPWD specification with latest modification.</th>
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<td>In case of conflict, the more stringent requirement will apply unless ruled otherwise by EPI/NTPC</td>
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<th>6.</th>
<th>Taxes and Duties</th>
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<td>All Taxes, Duties, Statutory levies such as VAT or any other similar Tax in the State concerned, Cess, Labour cess, Octroi, Entry Tax, Turn over Tax, Consignment Tax, Work Contract Tax, Service Tax, Toll Tax, Royalties, Levies and other Tax (es) or Duty (ies) etc as imposed by State / Central / Local Government Bodies from time to time for the Works, are included in the contract price. Income Tax and other Deductions of Taxes as applicable shall be deducted from RA Bills / due payment of the contractor.</td>
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<th>7.</th>
<th>Witnessing of Tender</th>
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The tender for the works shall not be witnessed by a contractor or contractors who himself / themselves has/have tendered or who may find has/have tendered for the same work. Failure to observe this condition would render, tenders of the contractors tendering as well as witnessing the tender, liable to summarily rejection.

8 Measurement of Work Done

Engineer-in-charge shall, except as otherwise provided, ascertain and determine measurement and the value in accordance with the contract work done.

All measurement of all items having financial value shall be entered in Measurement Book and/or level field book so that a complete record is obtained of all works perform under the contract.

All measurements and levels shall be taken jointly by EPI and by the contractor or his authorized representative at least once in a month during the progress of the work and such measurements shall be signed and dated by EPI and the contractor in token of their acceptance. If the contractor objects to any of the measurements recorded, a note shall be made to that effect with reason and signed by both the parties.

If the contractor or his authorized representative does not remain present at the time of measurements after the contractor has been given a notice three (3) days in advance or fails to countersign or to record objection within a week from the date of the measurement then such measurements recorded in his absence by EPI/NTPC shall be deemed be accepted by the Contractor.

The contractor shall, without extra charge, provide all assistance with every appliance labour and other things necessary for measurements and recording levels.

All work to be measured as per latestIS standards with up to date corrections.

The contractor shall give not less than seven days notice to EPI before covering up or otherwise placing beyond the reach of measurement any work In order that the same may be measured and correct dimension thereof be taken before the same is covered up or placed beyond the reach of measurement and shall not cover up and placed beyond reach of measurement any work without consent in writing from EPI / NTPC who shall within the aforesaid period of 7 days inspect the work, and if any work shall be covered up or placed beyond the reach of measurements without such notice having been given or consent being obtained in writing the same shall be uncovered at the contractor’s expense or in default thereof no payment or allowance shall be made for such work or the materials with which the same was executed.
EPI/NTPC may cause to check the measurement recorded jointly or otherwise as aforesaid and all provisions stipulated herein above shall be applicable to such checking of measurement or levels.

It is also a term of this contract that recording of measurements of any item of work in the measurement book and/or its payment in the interim, on account or final bill shall not be considered as conclusive evidence as to the sufficiency of any work or material to which it relates nor shall it relieve the contractor from liabilities from any over measurement defects noticed till completion of the defects liability period.

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<tr>
<th>Insurance</th>
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<td>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 NTPC 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:-</td>
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<tr>
<td>a. The work and the temporary works to the full value of such works.</td>
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<td>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.</td>
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<th>INSURANCE UNDER WORKMEN’S COMPENSATION ACT</th>
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<td>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. Whenever required by EPI the Contractor shall produce the policy or the policies of Insurance and the receipt of payment of the current premiums.</td>
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<th>THIRD CONTRACTOR INSURANCE</th>
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<td>Contractor is required to take third CONTRACTOR 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, and NTPC arising out of the execution of the works or temporary works. Whenever required by EPI the Contractor shall produce the policy or the</td>
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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 CONTRACTOR 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.

10 Contractor’s Plant and Equipment

The CONTRACTOR shall deploy sufficient plant & equipment of the required capacity 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 the CONTRACTOR shall be as decided by EPI/NTPC, 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 written permission 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/NTPC at its sole discretion shall take necessary action as deemed fit and decision of EPI/NTPC shall be final and binding on the contractor.

11 Discrepancies and adjustment of errors

The Several documents forming the contract are to be taken as mutually explanatory to one another, detailed drawings being followed in preference to small scale drawings and figured dimensions in preference to scale and Additional Conditions in preference to General Conditions.

12 Order of Precedence

In case of ambiguity in schedule of rates, General Conditions, Specifications, Drawings, the following order of precedence will prevail.

i) Rate of DSR-2014
ii) Drawings
iii) Bill of Quantities
iv) Additional Conditions / Corrigendum
v) Specifications
vi) General Conditions of Contract

13 Conflict in Documents

If there are varying or conflicting provisions made in anyone document
forming part of the contract, the Engineer-in-charge of EPI shall be the deciding authority with regard to the intention of the document and his decision shall be final and binding on the contractor.

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<tr>
<th>14</th>
<th>Documents</th>
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| Documents required to be maintained at site, one copy of following:  
  1. Contract Document  
  2. All Drawings  
  3. Specifications  
  4. Corrigendum  
  5. Reviewed shop drawings  
  6. Site order book  
  7. Other modifications to contract  
  8. Field test reports  
  9. Copy of approved work schedule and its updated revisions as approved.  
  10. Field quality plan approved by EPI/NTPC |

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<tr>
<th>15</th>
<th>Retention Money</th>
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| The person/persons whose tender(s) may be accepted (hereinafter called the contractor) shall permit EPI/ NTPC at the time of making any payment to him for work done under the contract to deduct a sum at 10% (Ten percent) from the gross amount of each running bill till full amount of Retention money of 10% (Ten percent) of agreement value or value of work (whichever is higher) is reached. If value of work exceeds the agreement value; Retention money (10%) will be recovered for the exceeded work. The amount shall be released after the defects pointed out by EPI/NTPC during liability period are rectified by Contractor and after specific approval by EPI/NTPC.  

All compensations or the other sums of money payable by the contractor under the terms of this contract may be deducted from, or paid by the sale of a sufficient part of his security deposit or from the interest arising there from or from any sums which may be due to or may become due to the contractor by EPI/NTPC on any account whatsoever and in the event of his Retention money being reduced by reason of any such deductions or sale as aforesaid. the contractor shall within 10 days make good in cash or fixed deposit receipt tendered by the State Bank of India or by Scheduled Banks or Government Securities (if deposited for more than 12 months) endorsed in favour of EPI/NTPC, any sum or Sums which may have been deducted from, or raised by sale of his Security Deposit or any part thereof. |

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<th>16</th>
<th>Registration</th>
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<td>The CONTRACTOR confirms that it holds EPF Code number, CST-TIN, VAT –TIN/ Sales tax on Works contract number, Service tax registration number, PAN (Permanent Account Number of Income Tax) etc. and shall be responsible for depositing EPF subscription and contribution for labour and</td>
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staff employed by it on the works and Service tax, other taxes, duties and
dues etc. as per statutory requirements and documentary evidence of same
shall be provided to EPI. 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. The CONTRACTOR shall comply with all
the requirements as per labour laws/acts. All the records in this regard shall
be maintained by the CONTRACTOR as per statutory requirements and
rules and shall be produced by the CONTRACTOR on demand if required.
In case, the bidders do not have PF Registration No & Sale Tax/VAT(in the
state of Odisha) registration the same shall be obtained by successful
bidder within one month from the date of LOI or before release of First RA
Bill.

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<th>17</th>
<th>Local Manpower</th>
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| Successful Bidder shall ensure maximum utilization of local manpower as
  for as possible |

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<tr>
<th>18</th>
<th>Association with EPI</th>
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| If desired by EPI, the CONTRACTOR shall be available / associate with EPI
  in meetings with Client for its portion of work at their own cost. The
  CONTRACTOR shall furnish all information and clarifications as and when
  required by EPI/NTPC. |

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<th>19</th>
<th>Non interference with other works</th>
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| 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. |

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<th>20</th>
<th>Compliance to statutory rules</th>
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| The CONTRACTOR shall ensure compliance with all Central, State and
  Local Laws, Rules, Regulations etc. as applicable or may be applicable
during the course of execution, maintenance etc. of the works and shall
  indemnify against any claim or damages whatsoever on such accounts.
The CONTRACTOR shall also keep EPI/NTPC indemnified at all times
  against infringement of any Patent or Intellectual Property rights. |

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<th>21</th>
<th>Payment</th>
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| The interim or running account bill shall be submitted by the contractor for
  the work executed on the basis of such recorded measurements on the
  format of EPI/NTPC in qua-duplicate on or before the date of every month
  fixed for the same by EPI / NTPC. In the event of the failure of the contractor
  to submit the bills, EPI shall prepare or caused to be prepared such bills in
  which events no claim whatsoever due to delays in payment including that of |
interest shall be payable to the contractor. Payment on account of amount admissible shall be made by EPI certifying the sum to which the contractor is considered entitled by way of interim payment at such rates as decided by EPI. The amount admissible shall be paid by 30th working day of presentation of the bill by the contractor to EPI together with the account of dismantled the materials if any.

Any such interim payments shall be regarded as payment by way of advances against final payment only and shall not preclude the requiring of bad, unsound or imperfect or unskilled work to be rejected, removed, taken away and reconstructed or re-erected. Any certificate given by EPI/NTPC relating to the work done or materials delivered forming part of such payment may be modified or corrected by any subsequent such certificates or by the final certificate and shall not by itself be conclusive evidence that any work or materials to which it relates is/are in accordance with contract and specifications. Any such interim payment, or any part thereof shall not in any respect conclude determine or affect in any way powers of EPI under the contract or any of such payments be treated as final settlement and adjustment of accounts or in any way vary or affect the contract.

Pending consideration of extension of date of completion, interim payments shall continue to be made without prejudice to the right of EPI to action under the terms of this contract or delay in the completion of work, if the extension of date of completion is not granted by EPI/NTPC. The Contractor shall have no claim in case the payments are delayed due to any reason whatsoever.

22 Compensation for delay

If the contractor fails to maintain the required progress as mentioned in contract data 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 EPI, on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below as EPI may decide (whose decision in writing shall be final and binding) on the amount of tendered value of the work for every completed day/month (as applicable) that the progress remains below that specified in contract data or that the work remains incomplete.

i) Compensation for delay of work – at the rate of 1/2% per week of delay to be computed 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 contract amount.

23 Work subject to audit

The work executed by the CONTRACTOR shall be subject to audit and
quality control checks from Quality Control Division & Technical audit of EPI/NTPC, inspecting Agency of the Client and Chief Technical Examiner of Central Vigilance Commission, Govt. of India. In the eventuality of any defect/sub standard works as brought out in the report or noticed otherwise at any time during execution, maintenance period etc., the same shall be made good by the CONTRACTOR without any extra cost. In case the CONTRACTOR fails to rectify the defect/sub- standard work within the time period stipulated by EPI/NTPC, necessary action as deemed fit shall be taken by EPI/NTPC and decision of EPI/NTPC shall be final and binding on the contractor.,

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<th>24</th>
<th>False statement</th>
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<td>In case, at a later stage, it is found that the CONTRACTOR has submitted incorrect, false details and credentials resulting in apprehensions on the capabilities of CONTRACTOR with regard to quality &amp; timely completion of works, financial capabilities etc. EPI/NTPC can terminate this agreement solely at their option. In this eventuality the CONTRACTOR shall be liable for the losses suffered by EPI/NTPC and further CONTRACTOR shall have no claim on EPI/NTPC, whatsoever.</td>
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<th>25</th>
<th>Statutory Approvals</th>
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<td>The contractor is responsible for obtaining all statutory approvals during construction and thereafter. Necessary liasoning to be undertaken wherever required with no extra claim. All the approvals shall be taken before the scheduled completion period and in any case before the work can be taken over.</td>
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<th>26</th>
<th>Price Escalation</th>
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<tr>
<td>Escalation shall be applicable as per CPWD norms Clause No 10CC</td>
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<th>27</th>
<th>Additional / Extra Items</th>
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<td>The following procedures shall be meticulously adopted in case of any additional / extra items.</td>
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<td>i) EPI shall issue a Contemplated Change Notice (CCN) in the format enclosed as Annexure.</td>
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<td>ii) Based upon the requirement stipulated in CCN contractor shall submit analysis to reflect financial implications if any, within 7 days from issue of CCN. The price analysis shall be based upon rates given in bill of items for the similar works or can be derived on the basis of basic rate of material and labour appended with annexure, in case the item is not available in bill of items/ DSR-2014.</td>
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<td>iii) After review and approval of analysis by Engineer In-charge of EPI / NTPC, change order shall be issued by EPI in the format enclosed with the annexure to enable contractor to execute item.</td>
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iv) For substitute items contractor shall produce price analysis for the approval of EPI / NTPC and adjustment in the contract amount accordingly. No overheads and profits shall be applicable against substituted items.

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<th>28</th>
<th>Variation</th>
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<td>The variation limit shall be ± 10% of the value of Contract for works within the site and of similar nature and specification at the same accepted rate. There is no limit of variations for individual Items.</td>
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<tr>
<th>29</th>
<th>Codes</th>
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<tr>
<td>1. Applicable British Standard (B.S)/ Indian Standards (IS) and in the absence of definite provision on particular issue in the specification / codes, reference may be made to relevant latest Codes recommended to be used and good engineering practices and / or as per instruction / suggestion of EPI / NTPC.</td>
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<th>30</th>
<th>Safety Measures</th>
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<td>It shall be the sole responsibility of the Contractor to ensure all safety measures giving proper, prior notices etc. and obtaining prior permission from concerned local authorities as per bye-laws or directions issued by them at his own cost. No claim of the contractor in this regard shall be entertained. Proforma of Safety Measures (to be provided by EPI) shall be attached along with each bill duly filled by the contractor and certified by EPI.</td>
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<th>31</th>
<th>Design Mix</th>
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<td>The CONTRACTOR is required to submit his design mix for various grades of concrete for approval of EPI/NTPC keeping in view the requirement stipulated in the technical specification and relevant codes.</td>
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<th>32</th>
<th>Materials to be provided by the contractor</th>
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<td>The contractor shall at his own expense, provide all materials, required for the works. The contractor shall at his own expense and without delay supply to EPI samples of materials to be used on the work and shall get approved in advance. All such materials to be provided by the Contractor shall be in conformity with the specification laid down or referred to in the contract. The contractor shall if requested by EPI furnish proof to the satisfaction of EPI that the materials so comply. EPI shall within 15 days of supply of samples or within such further period as he may require intimate to the contractor in writing whether samples are approved by them or not. If samples are not approved the contractor shall forthwith arranged to supply to EPI for his</td>
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approval fresh samples complying with the specifications laid down the contract. When materials are required to be tested in accordance with specifications approval of EPI/NTPC shall be issued after the test results are received.

The contractor shall, at his risk and cost, submit the samples the materials to be tested or analysis shall not make use of or incorporate in the work any materials represented by the samples until the required tests or analysis have been made and materials finally accepted by EPI. The contractor shall not be eligible for any claim or compensation either arising any delay in the work or due to any corrective measures required to be taken on account of and as a result of testing of materials.

The contractor shall at his risk and cost make all arrangements and shall provide all facilities as EPI may require for collecting and preparing the required nos. of samples for such tests at such time and to such place or places as may be directed by EPI and bear all charges and cost of testing. EPI / NTPC shall at all time 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 in obtaining the right to such access.

EPI shall have full powers to require the removal from the premises of all material's which in their opinion are not in accordance with the specifications and in case of default EPI 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. EPI shall also have full powers to require other proper materials to be substituted thereof and in case of default EPI may cause the same to be supplied and all costs which may attain such removal and substitution shall be borne by the contractor.

**Sub-standard Material**

Any material/item/fitting/fixtures rejected by EPI / NTPC shall be removed from the site within 48 hours of issue of instructions to this effect by EPI. Failing this, the EPI shall have the rights to get these removed and the Contractor shall have no claim whatsoever in this regard.

**Alterations, Additions and Omissions**

EPI/NTPC can make any variation of the form, quality or quantity of the works or any part thereof that may, in their opinion be necessary and for that purpose, or if for any other reason it shall in his opinion be desirable, they shall have power to order in writing to the contractor to do and the contractor shall do any of the following:

i) Increase or decrease in the quantity of any work included in the
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| **contract in which case the value of contract may be increased or decreased.**  
ii) Omit any such work.  
iii) Change the levels, lines, position and dimension of any part of the works and  
iv) Execute additional work of any kind necessary for the completion of the works and no such variation shall in any way vitiate or invalidate the contract, but the value, if any of all such variations shall be taken into account to ascertain the amount of the Contract Price.  
v) The contractor shall not effect any of the aforementioned changes without the written order of EPI / NTPC. |   |
| **35** | **Sign Board** |
| Contractor will arrange to fabricate and erect sign board at his own cost showing name of work, name of NTPC, name of Architect/Consultants, name of EPI, date of commencement and completion etc of size and design as approved by EPI/NTPC. |   |
| **36** | **Dismantled Material** |
| The contractor shall treat all materials obtained during dismantled of structure, excavation of the site for a work etc as the property of NTPC and such materials shall be disposed off to the best advantage of NTPC according to the Codal provision. |   |
| **37** | **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 of the date of letter of Intent. 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 security deposit money absolutely.  
Within 7 (Seven) 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. 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 |   |
37.2 Charge. The compensation for delay as per Clause -22 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.

If the work(s) be delayed by:

i) force-majeure or
ii) serious loss or damage by fire, or
iii) civil commotion of workmen, strike or lockout, affecting any or the trades employed on the work, or
iv) 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) 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.

37.3 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.

38 Deviation, extra items and pricing

In the case of extra item(s) the contractor may within fifteen days of receipt of order or occurrence of the item(s) claim rates, supported by proper analysis, for the work and the Engineer-In-Charge of EPI shall within one month of the 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/other prevailing codes as approved NTPC and the contractor shall be paid in accordance with the
<table>
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<tr>
<th>39</th>
<th>Deviation, substituted items, pricing</th>
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<tbody>
<tr>
<td>In the case of substituted items, the rate for the agreement item (to be substituted) and substituted item shall also be determined in the manner as mentioned in the aforesaid para.</td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>If the market rate for the substituted item so determined is more than the market rate of the agreement item (to be substituted) the rate payable to the contractor for the substituted item shall be the rate for the agreement item (to be substituted) so increased to the extent of the difference between the market rates of substituted item and the agreement item (to be substituted).</td>
</tr>
<tr>
<td>(b)</td>
<td>If the market rate for the substituted item so determined is less than the market rate of the agreement item (to be substituted) the rate payable to the contractor for the substituted item shall be the rate for the agreement item (to be substituted) so decreased to the extent of the difference between the market rates of substituted item and the agreement item (to be substituted).</td>
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<tr>
<th>40</th>
<th>Deviation, Deviated Quantities, Pricing</th>
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<tr>
<td>In the case of contract items, substituted items, contract cum substituted items, which exceed the limits laid down in Clause -27, 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 the Engineer-In-Charge of EPI shall within one month 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/other prevailing codes as approved by NTPC and the contractor shall be paid In accordance with the rates so determined.</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>The provisions of the preceding paragraph shall also apply to the decrease in the rates of items for the work in excess of the limits laid down in Clause-27 and the Engineer-in-Charge of EPI shall after giving notice to the contractor within one month of 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 one month of expiry of the said period of fifteen days having regard to the market rates or current schedule of rate or other prevailing codes as approved by NTPC.</td>
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</tbody>
</table>
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 of EPI which he has executed during the preceding quarter failing which the contractor shall be deemed to have waived his right.

41. **Action in case work not done as per Specifications**

All works under or in course of execution or executed in pursuance of the contract shall at all times be open and accessible to the inspection and supervision of the Engineer-in-Charge, his authorized representative in charge of the work and all the superior officers, officer of the Quality Control Organization of EPI / NTPC and of the Cabinet (Technical) Vigilance, and the contractor shall, at all times, during the usual working hours and at all other times at which reasonable notice of the visit of such officers has been given to the Contractor either himself or present to receive orders and instructions or have a responsible agent duly accredited in writing, present for that purpose, Orders given to the Contractor's agent shall be considered to have the same force as they had been given to the contractor himself.

If it shall appear to the Engineer-In-charge of EPI or his higher authority or his authorized subordinates in charge of the work or to the Cabinet (Technical) Vigilance or his subordinate officers, that any work has been executed with unsound, imperfect or unskillful workmanship, or with materials or article provides by him for the execution of the work which are unsound or of a quality inferior to that contracted or otherwise not in accordance with the contract the contractor shall, on demand in writing which shall be made within the period specified by the Engineer-in-Charge of EPI/NTPC, 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 charge and cost. In the event of the contractor, failing do so within a period specified by the Engineer-in-Charge of EPI in his demand aforesaid, then the contractor shall be liable to pay compensation at the same rate as under clause - 22of ACC of the contract (for non-completion of the work in time) for this default.

In such case the Engineer-in-charge may not accept the item of work at the rates applicable under the contract but may accept such items at reduced rates as the competent authority may consider reasonable during the preparation of on account bills or final bill if the item is so acceptable without detriment to the safety and utility of the item and the structure and
incidental items rectified, or removed and re-executed at the risk and cost or contractor. Decision of the Engineer-in-Charge to be conveyed in writing in respect of the same will be final and binding on the contractor.

42 **Contractor Liable for Damages, defects during maintenance period**

If the contractor or his working people or servants shall break, deface, injure or destroy any part of building in which they may be working, or any building, road, road curb, fence, enclosure, water pipe, cables, drains, electric or telephone post or wired, trees, grass or grassland, or cultivated ground contiguous to the premises on which the work or any part is being executed, or if any damage shall happen to the work while in progress, from any cause whatever or if any defect, shrinkage or other faults appear in the work within defect liability period after a certificate final or otherwise of its completion shall have been given by the Engineer-in-charge of EPI as aforesaid arising out of defect or improper materials or workmanship the contractor shall upon receipt of a notice in writing on that behalf make the same good at his own expense or in default the Engineer-in-charge of EPI cause the same to be made good by other workmen and deduct the expense from any sums that may be due or at any time thereafter may become due to the contractor, or from his security deposit or the proceeds of sale thereof or of a sufficient option thereof. The security deposit of the contractor shall not be refunded before the expiry of defect liability period after the issue of the certificate final or otherwise, of completion of work, or till the final bill has been prepared and passed whichever is later.

In case of Maintenance and Operation works of Electrical & Mechanical services, the security deposit deducted from contractors shall be refunded within one month from the date of final payment or within one month from the date of completion of the defect liability period whichever is earlier.

43 **Recovery against Labour Safety**

In respect of all labour directly or indirectly employed in the work for the performance of the contractor’s part of this contract, the contractor shall at his own expense arrange for the safety provisions as per CPWD Safety Code framed from time to time and shall at his own expense provide for all facilities in connection therewith. Failing which, necessary action as deemed fit shall be taken by EPI/NTPC.

44 **Compensation**

All Sums payable by way of compensation under any of these conditions shall be considered as reasonable compensation to be applied to the use of Government without reference to the actual loss or damage sustained and whether or not any damage shall have been sustained.

45 **Approval of Engineer-in-charge**
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<th>46</th>
<th><strong>Contractor to indemnify Govt. against Patent Rights</strong></th>
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<tr>
<td>The contractor shall fully indemnify and deem indemnified EPI/NTPC against any action, claim or proceeding relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any article or part thereof included in the contract. In the event of any claims made under the action brought against EPI/NTPC in respect of any such matter as aforesaid the contractor shall be immediately notified thereof and the contractor shall be at liberty, at his own expenses, to settle any dispute or to conduct any litigation that may arise there from, provided that the contractor shall not be liable to indemnify EPI/NTPC if the infringement of the patent or design or any alleged patent or design right is the direct result of an order passed by the Engineer-in-Charge of EPI/NTPC in this behalf.</td>
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<tr>
<th>47</th>
<th><strong>Unfiltered water supply</strong></th>
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<td>The contractor(s) shall make his / their own arrangement for water required for the work and nothing extra will be paid for the same, This will be subject to the following conditions.</td>
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<tr>
<td>i</td>
<td>That the water used by the contractor(s) shall be fit for construction purposes to the satisfaction of the Engineer-in-Charge of EPI/NTPC.</td>
</tr>
<tr>
<td>ii</td>
<td>The Engineer-in-charge of EPI shall make alternative arrangements for supply of water at the risk and cost of contractor(s) if the arrangements made by the contractor(s) for procurement of water are in the option of the Engineer-in-Charge of EPI/NTPC, unsatisfactory.</td>
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<tr>
<th>48</th>
<th><strong>Levy/Taxes payable by Contractor</strong></th>
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<tbody>
<tr>
<td>i</td>
<td>The contractor shall deposit royalty and obtain necessary permit for supply of the red earth, moorum, sand chips bajri, stone, kankar, etc. from local authorities.</td>
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<tr>
<td>ii</td>
<td>If pursuant to or under any law, notification or order any royalty, cess of the hike becomes payable to the Government of India and does not at any time become payable by the contractor to the State Government/Local authorities in respect of any material used by the contractor in the works then in such a case, it shall be lawful to the Government of India and it will have the right and be entitled to recover the amount paid in the circumstances as aforesaid from the dues of the contractor.</td>
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<tr>
<td>49</td>
<td><strong>Conditions for reimbursement of levy/taxes if levied after receipt of tenders</strong></td>
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<tr>
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<tr>
<td>i</td>
<td>All tendered rates shall be inclusive of all taxes and levies payable under respective statutes. However, pursuant to the Constitution (46th Amendment) Act, 1982, if any further tax or levy is imposed by Statute, after the last stipulated date for the receipt of tender including extensions if any and the contractor thereupon necessarily and properly pays such taxes/levies the contractor shall be reimbursed the amount so paid, provided such payments, if any, is not, in the opinion of Engineer-in-charge of EPI (whose decision shall be final and binding on the contractor) attributable to delay execution of work within the control of the contractor.</td>
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<tr>
<td>ii</td>
<td>The contractor shall keep necessary books of accounts and other documents for the purpose of this condition as may be necessary and shall allow inspection of the same by EPI as may be required from time to time.</td>
</tr>
<tr>
<td>iii</td>
<td>The contractor shall, within a period of 30 days of the imposition of any such further tax or levy, pursuant to the Constitution (Forty Sixth Amendment) Act 1982, give a written notice thereof to the Engineer-in-Charge of EPI that the same is given pursuant to this condition, together with all necessary information relating thereto.</td>
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<tr>
<td>50</td>
<td><strong>Release of Security Deposit/Retent:</strong></td>
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<td></td>
<td>The entire Retention Money along with EMD amount shall be released to the contractor after 28 days of expiry of defect liability period if all the defects are rectified by contractor, raised during defect liability period</td>
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<tr>
<td>51</td>
<td><strong>Contractor’s risks</strong></td>
</tr>
<tr>
<td></td>
<td>All risks of loss of or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the contract other than the excepted risks are the responsibility of the contractor.</td>
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<tr>
<td>52</td>
<td><strong>Covering up of Contract Works</strong></td>
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<tr>
<td></td>
<td>No part of the contract works shall be covered up without the approval of the EPI/NTPC and the contractor shall afford full opportunity for examination and inspection by EPI / NTPC.</td>
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<tr>
<td></td>
<td>The Contractor shall give due notice to EPI about the works to be covered up for their measurement and examination. EPI shall within a reasonable time attend for the purpose of examining such work, unless the contractor</td>
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is specifically advised in writing of EPI’s willingness not to attend such examination in which case the contractor may proceed further with contract works.

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<tr>
<th>53</th>
<th><strong>Site Order Book</strong></th>
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<td></td>
<td>The contractor shall maintain a site order book at site of the work. Any special orders and instructions to be issued to the contractor at site will be recorded in this book which will be numbered and initialed by EPI/NTPC. The contractor will however sign all the orders as a token of information received by him and take action accordingly.</td>
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<tr>
<th>54</th>
<th><strong>Inspection and Testing</strong></th>
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<td></td>
<td>As and when required by EPI / NTPC, the contractor shall provide all facilities for inspection of contract works and materials at his own cost. All materials shall be of highest standard, quality and kind. All requisite cost as per IS/Tender stipulations are to be carried out by the contractor at his own cost and results submitted to EPI. This, however, does not absolve the contractor from his responsibility for the overall quality, kind, strength and stability of the structures.</td>
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<tr>
<th>55</th>
<th><strong>Safety, Security and protection of the Environment</strong></th>
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<td></td>
<td>The Contractor shall, throughout the execution and completion of the works and the remedying of any defects therein:</td>
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<tr>
<th>56</th>
<th><strong>Guarantee</strong></th>
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<tr>
<td></td>
<td>All guarantees and test certificate for the entire work shall be transferred to EPI/NTPC by the contractor on virtual/interim completion of the work. All guarantees shall be for the values and duration as mentioned in specification/item description.</td>
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<tr>
<th>57</th>
<th><strong>Language</strong></th>
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<tr>
<td></td>
<td>All correspondence, drawings and notations relating to this Contract must be in English</td>
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<tr>
<th>58</th>
<th><strong>Water Supply</strong></th>
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<tr>
<td></td>
<td>The contractor shall make their own arrangements for water required for construction as well as for drinking and other purposes for their staffs and labour and the personnel of EPI / NTPC.</td>
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<tr>
<th>59</th>
<th><strong>Electricity</strong></th>
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<tr>
<td>Section</td>
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<tr>
<td><strong>i)</strong> Contractor shall obtain temporary power connection from Local Authorities at his cost for construction purposes.</td>
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<tr>
<td><strong>ii)</strong> Contractor shall make his own arrangements for further distribution as per their requirement and also the requirement of EPI and cost of cables switches, fuses, meters etc. shall be borne by contractor. It is to be noted that power from local authority may not be continuous and there may be possibilities of disruption of power. Hence contractor shall install sufficient number of generators of adequate capacity duly approved by EPI/NTPC bearing all operating and installation cost right from the date of commencement of the work in the scope of the contractor.</td>
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</tr>
<tr>
<td><strong>iii)</strong> EPI/NTPC reserves the right to supply power at mutually agreed rates as and when sufficient availability of same is attained. Till such time the contractor shall be required to supply power to EPI/NTPC/such vendors as EPI /NTPC desires at mutually agreed rates.</td>
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<tr>
<td><strong>iv)</strong> Contractor shall provide power free of cost to the temporary office facilities of EPI, NTPC, Consultant as required.</td>
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<tr>
<td><strong>60</strong></td>
<td><strong>Gate keeper &amp; Watchman</strong></td>
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<tr>
<td>The Contractor shall provide, maintain at his own expense gate keepers and watchmen to ensure at all times effective protection of the works, materials and workmen, until completion of the project, at his own risk and cost.</td>
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<tr>
<td><strong>61</strong></td>
<td><strong>Recovery</strong></td>
</tr>
<tr>
<td>Any amount found recoverable from the contractor shall be recovered without prejudice to any other mode of recovery.</td>
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<tr>
<td>In case of difference or ambiguity in Hindi an English version the English version will prevail.</td>
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<tr>
<td><strong>62</strong></td>
<td><strong>Approval from Client</strong></td>
</tr>
<tr>
<td>The CONTRACTOR shall be responsible for obtaining all approvals from EPI/ Client with regard to quality of materials &amp; workmanship and measurements etc. the work</td>
<td></td>
</tr>
<tr>
<td><strong>63</strong></td>
<td><strong>Contractors Use of Sites</strong></td>
</tr>
<tr>
<td>The Contractor is restricted to construction sites as marked on the drawings for the execution of the work. Contractor must obtain approval from EPI before proceeding with work outside.</td>
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<tr>
<td><strong>64</strong></td>
<td><strong>Project Meetings</strong></td>
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</table>
1. Hold project meetings at times and locations approved by EPI/NTPC.
2. Notify participants of meetings.
3. Contractor shall record minutes of meetings and distribute to participants within 3 days of meeting.

**Setting Out of Work**

1. Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.
2. Provide devices needed for layout and construction work.
3. Supply stakes and other survey markers required for laying out work.
4. The Contractor has to arrange full time Survey team along with total station and other tools for checking of all co-ordinates/position of all items during execution.

**Location of Equipments and Fixtures**

1. Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
2. Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
3. Inform EPI of impending installation and obtain their approval for actual location.
4. Submit field drawings to indicate relative position or various services and equipment when required by EPI/NTPC.

**Concealment**

Contractor shall conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

**Cutting & Patching**

1. Contractor shall obtain approval of EPI/NTPC before cutting, boring or sleeving load-bearing members.
2. Cut and patch as required to make work fit.
3. Make cuts with clean, true, smooth edges.
4. Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work.

**Billing Documents**

Following documents shall be enclosed by contractor along with submission of each bill otherwise the same shall not be accepted by EPI for checking and certification of payment.

a. Monthly progress reports in the format as issued by EPI/NTPC –
Sample report is available with EPI/NTPC for Contractor’s reference.
b. Cube test reports.
c. Safety measurement certificate.
d. All the information/documents contained in relevant check lists. Formats for (b), (c) and (d) shall be provided to the contractor by EPI.

**70 Brand Name**

The specific reference in the Specifications and documents to any material by trade name, make or catalogue number shall be construed as establishing standard or quality and performance and not as limited competition. However, contractor may offer other similar equipments/material, provided it meets the specified standard design & performance requirements subject to approval by EPI / NTPC.

**71 Co-ordination Drawings**

This is a Percentage Rate base contract. Therefore it shall be the Contractors responsibility to ensure complete co-ordination between works of various agencies such as Civil, Electrical, Utilities, and Plumbing etc. The Contractor shall deemed to have considered this aspect carefully while quoting percentage.

**72 Site Meetings**

Site meetings shall be held at regular intervals and in addition to other meeting required by EPI/NTPC. There shall be at least one site meeting per fortnight in the presence of EPI/NTPC to discuss and co-ordinate the work. The Contractor shall provide responsible member of his organization who is authorized to commit and bind the contractor to any agreement reached during said meeting.

**73 Submission of Manuals / Catalogues**

Maintenance manuals, product catalogues, all warranties and guarantees against each section of work shall be submitted hardbound in triplicate on completion as per direction of EPI.

**74 Shop Drawings**

The Contractor shall submit shop/fabrication drawings for all services and works like Aluminium /Structural steel works /Electrical Conduit Layout etc as required and desired by EPI/NTPC. Nothing extra shall be paid on this account.

**75 Measures to be followed for protection and preservation of landscape**

a) Avoid or limit major construction activity during monsoon
season to minimize and avoid soil erosion due to rain fall.

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<th>76</th>
<th>Plan to be submitted</th>
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<tr>
<td>Contractor to submit a construction activity, material storage and vehicular movement plan before starting construction and submit the same for EPI/NTPC/ GRIHA consultant approval. The plan is to be prepared to ensure the following and is to be applied effectively during the whole construction phase:</td>
<td></td>
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<tr>
<td>i) Demarcate area on the site plan to which the site activities would be limited during construction by the contractor. The demarcated area should be separated from the rest of the site through a physical barrier.</td>
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<tr>
<td>ii) Construction materials such as sand, aggregate etc. to be stored in demarcated areas within low height enclosures to limit spillage, waste and site contamination due to winds.</td>
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<tr>
<td>iii) Control plan clearly stating measures to stop and contain spills, to dispose off contaminated material and hazardous waste (hazardous waste include pesticides, paints, cleaner and petroleum products etc.) cover all loose stored material with geo-textile or any impervious fabric/covering.</td>
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<tr>
<td>iv) Location should be identified on the construction site to store the used/scrap wastes. Both these wastes should be separately stored in Bins and handed over to authorized agencies for safe disposal.</td>
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<th>77</th>
<th>Preservation of tree/vegetation</th>
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<tr>
<td>Existing trees and other forms of vegetation to be preserved by avoiding disturbance/damage due to construction activities. All existing vegetation should be marked on the site survey plan. The tree survey must be carried out and data must be recorded before starting construction activities. Adequate fencing to avoid disturbance / damages to trees/other vegetation to be provided.</td>
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<tr>
<th>78</th>
<th>Top Soil Preservation</th>
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<tbody>
<tr>
<td>Adequate measures to excavate, preserve, maintain fertility and lay back top soil for minimum compacted depth of 300mm as per GRIHA consultant guidelines to be followed by the contractor.</td>
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<th>79</th>
<th>Sanitation/safety facilities for construction workers</th>
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<tr>
<td>Provision for basic facilities of sanitation &amp; drinking water and safely</td>
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construction works, safety of equipment and machinery etc. as per the various guidelines laid down in the National Building Code 2005 for construction safety for construction workers and for Health and Sanitation facilities for workers/working residing on site. This to include, but not limited to, safety equipment (safety helmets, jackets, boots, gloves etc), safety nets/harnesses, appropriate warning/safety signs, fire extinguishers, adequate light for working during evenings/night, regular maintenance and repairs of machinery/equipments and adequate sanitation/potable drinking water facilities.

### 80 Controlling Air Pollution

**i** Provide action plan to reduce and restrict Air Pollution during construction. Necessary measures such as hoarding/sheeting/dust screens around site/construction area, mulching/gravel stoning of pedestrian movement paths, limit vehicular movement paths/ parking areas (which should be hard paved or graveled) spraying water etc. to reduce dust pollution on site to be submitted for EPI/NTPC/GRIHA consultant approval and to be effectively followed during construction phase.

**ii** Vehicles with dusty loads to be covered with impervious sheeting before they enter or exit the site.

**iii** All Gensets used should meet recommended pollution norms and should be maintained properly. Min. stack height based on building height and DG Set capacity to be provided and spillage of fuel/lubricant to be controlled.

### 81 Testing Laboratory Services

Particular requirements for inspection and testing to be carried out by testing laboratory designated by EPI/NTPC are specified under various sections.

Where tests or inspections by designated laboratory reveal work not in accordance with contract requirements, Contractor shall pay costs for additional tests or inspections as EPI may require to verify acceptability of corrected work.

### 82 Contractor’s Responsibilities

1. Furnish labour and facilities to:
   
   i) Provide access to work to be inspected and tested.
   
   ii) Facilitate inspections and tests.
   
   iii) Make good work disturbed by inspection and test.
   
   iv) Provide storage on site for laboratory’s exclusive use to store equipment and cure test samples.
   
   v) Provide all test equipments required for carry out field tests.

2. Notify EPI sufficiently in advance of operations to allow for
3. Where Materials are specified to be tested, deliver representative samples in required quantity to testing laboratory.

4. Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by EPI/NTPC.

### House Keeping

**General:**

1. Conduct cleaning and disposal operations to comply with local authority and antipollution Laws.

2. Store volatile waste in covered metal containers and remove from premises at the end of each working day.

3. Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

**Materials:**

Use only cleaning materials recommended by manufacturer of surface to be cleaned and as recommended by cleaning material manufacturer.

**Cleaning during:**

i) Provide on-site containers for collection of waste materials and debris

ii) Dispose of waste materials and debris off site.

iii) Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems

**Final Cleaning:**

i) Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials, from interior and exterior finished surfaces including glass and other polished surfaces.

ii) Clean lighting reflectors, lenses and other lighting surfaces.

iii) Broom clean paved surfaces: rake clean other surfaces of grounds.

iv) Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
Project Record Documents

Record Drawings (As built drawings)

i) Contractor shall provide four sets of as built drawings. One set shall be reproducible transparency on plastic film and two cp's. The above requirements are apart from the requirement of municipal authorities, which are also to be met by the Contractor.

ii) Maintain project record drawings and record accurately deviations from Contract documents.

iii) Record changes in red. Mark on one set of prints and at completion of project and prior to final inspection by Engineer, neatly transfer notations to second set and submit both sets to EPI.

iv) Record following information:

a. Depths of various elements of foundation in relation to datum.

b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvement.

c. Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.

d. Field changes of dimension and detail.

e. Changes made by Site Order/CCN.

v) The above set of as built drawings shall be submitted before submission of final bill.

Construction Photographs

1. General
Provide construction photographs in accordance with procedures and submission requirements specified in this Section.

2. Progress Photographs
a. Sizes: 200x300mm.

b. Type: Gloss and colour.


d. Number of prints required: 3 sets.(EPI / Client / Consultant)

e. Identification: Typewritten name and number of project and date of exposure on 25x.50mm white patch in upper right hand corner

f. Viewpoints: Interior and exterior location: viewpoints determined by
3. Final Photographs  
   i) Sizes: 200x300mm.  
   ii) Type: Gloss and colour.  
   iv) Number of prints required: 4 sets.  
   v) Identification: Typewritten name and number of project and date of exposure on reverse side.

4. Number of viewpoints:  
   i) Each side of buildings for total of 4 for each building.  
   ii) Interior of rooms and finishes for total of 8 for each building.  
   iii) Locations of viewpoints determined by Engineer-in-charges.

86  Only approved make of OPC/Specified cement to be used. In case of use of other makes in exceptional circumstances, that too after prior written approval of EPI/ NTPC, the recovery at prevailing market rates shall be made.

87  **Employment of Technical Staff and employees**

   i) Contractors Superintendence, Supervision, Technical Staff & Employees  
      The contractor shall provide all necessary Superintendence during execution of the work and as along thereafter as may be necessary for proper fulfilling of the obligations under the contract.

      The contractor along with bidding of the tender, intimate in writing to the Engineer-in-Charge of EPI the name, qualifications, experience, age, address and other particulars along with certificates, of the technical representative to be in charge of the work. If there is any change then the new documents qualifications and experience shall be submitted by the contractor. The Engineer-in-charge of EPI shall within 15 days of issue of letter of acceptance intimate in writing his approval or otherwise it is deemed to be approved. Any such approval may at any time be withdrawn and in case of such withdrawal the contractor shall appoint another such representative according to the provisions of this clause. Decision of EPI shall be final and binding on the contractor in this respect.

88  Clause No. 28.3 of GCC stands deleted
<table>
<thead>
<tr>
<th>Cost of work (Rs. In Crore)</th>
<th>Contract period (Months)</th>
<th>Requirement of Technical Staff</th>
<th>Minimum experience (Years)</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 300</td>
<td>20</td>
<td>(i) Project Manager with degree in corresponding discipline of Engineering</td>
<td>1</td>
<td>10 Principal Technical Representative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Graduate Engineer (One Mechanical, One Civil, One Electrical)</td>
<td>3</td>
<td>5 Technical Representative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Graduate Engineer or Diploma Engineer</td>
<td>3</td>
<td>Nil Technical Representative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Planning / Quantity Surveyor</td>
<td>1</td>
<td>5 Technical Representative</td>
</tr>
</tbody>
</table>

Rate of recovery in case of non compliance of above be stipulated at following rates:-

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Qualification</th>
<th>Experience (years)</th>
<th>Rate of recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Project Manager with Degree</td>
<td>10</td>
<td>Rs. 50,000/- p.m.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Graduate Engineer</td>
<td>5</td>
<td>Rs. 25,000/- p.m.</td>
</tr>
<tr>
<td>(iii)</td>
<td>Graduate Engineer or Diploma Engineer</td>
<td>NIL, 5</td>
<td>Rs. 15,000/- p.m.</td>
</tr>
<tr>
<td>(iv)</td>
<td>Planning / Quantity Surveyor</td>
<td>5</td>
<td>Rs. 25,000/- p.m.</td>
</tr>
</tbody>
</table>

1) Make of Material:- Makes mentioned in the tender documents are indicative only and final approval of makes shall be given by EPI / NTPC.
2) Diversion or replacement by cable of 33KV/11KV lines, dismantling of existing buildings, tree cutting, removal of electric feeder lines etc for making site hindrance free shall be done by contractor. Cost to be included in the bid & shall be quoted separately.
The tenderer shall provide ‘Sign Board (s)’ as per design approved by EPI and/or Client.
CONTEMPLATED CHANGE NOTICE

To

Submit Quotation to :

Project No.

Contractor

CCN No

Sub :

Date

It is proposed to make the following change in the work. You are requested to quote a firm price for any revision to the contract amount arising from the change. No work should be undertaken on this change until a change order / written authorization has been signed and issued.

Quotation to be submitted with 7 days of the date of this notice.

The work shall conform to the contract documents where applicable unless otherwise stated.

Initiator

____________________________________________________

Reason for Change

____________________________________________________
CHANGE ORDER

Project No.                      Change Order No.

Location

Description : Construction of Medical College & Hospital at Sundergarh, Odisha

Project Management & Execution Consultant : -
Architect : -

Contractors Name and Address

<table>
<thead>
<tr>
<th>Original Amount of Contract</th>
<th>Approved C.O. Amount to Date</th>
<th>Present C.O. Amount</th>
<th>Revised C.O. Amount</th>
<th>Revised Contract Amount</th>
</tr>
</thead>
</table>

Description of Change – Refer CNN No.

Recommended by: M/s EPIL

Approved by:
INTEGRITY PACT

Between

Engineering Projects (India) Ltd. (EPI) hereinafter referred to as “The Principal”,

And

………………………………………………… hereinafter referred to as “The Bidder / Contractor”

Preamble

The Principal intends to award, under laid down organizational procedures, contract/s for …………………………….. The Principal values full compliance with all relevant laws of the land, rules, regulations, economic use of resources and of fairness / transparency in its relations with its Bidder(s) and / or Contractor(s).

In order to achieve these goals, the Principal will appoint an Independent External Monitor (IEM), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 - Commitments of the Principal

1.) The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:

   a) No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

   b) The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

   c) The Principal will exclude from the process all known prejudiced persons.
2) If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the IPC/PC Act, or if there be a substantive suspicion in this regard, the Principal will inform the Chief Vigilance Officer and in addition can initiate disciplinary actions.

Section 2 - Commitments of the Bidder(s) / Contractor(s)

1) The Bidder(s) / Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.

a) The Bidder(s) / Contractor(s) will not, directly or through any other person or firm, offer, promise or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material or other benefit which he / she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

b) The Bidder(s) / Contractor(s) will not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

c) The Bidder(s) / Contractor(s) will not commit any offence under the relevant IPC / PC Act; further the Bidder(s) / Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

d) The Bidder(s) / Contractor(s) of foreign origin shall disclose the name and address of the Agents / representatives in India, If any. Similarly the Bidder(s) / Contractor(s) of Indian Nationality shall furnish the name and address of the foreign principals, if any, Further details as mentioned in the “Guidelines on Indian Agents of Foreign Suppliers” shall be disclosed by the Bidder(s) / Contractor(s). Further, as mentioned in the Guidelines
all the payments made to the Indian agent / representative have to be in Indian Rupees only.

e) The Bidder(s) / Contractor(s) will, when presenting his bid, disclose any and all payments he has made, is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2) The Bidder(s) / Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 - Disqualification from tender process and execution from further contracts

(1) If the Bidder(s) / Contractor(s), before award or during execution has committed a transgression through a violation of Section 2, above or in any other form such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s) / Contractor(s) from the tender process or to terminate the contract, if already signed for such reason.

(2) If the Bidder/ Contractor has committed a serious transgression through a violation of section – 2 such as to put his reliability or credibility into question, the principal is entitled also to exclude the Bidder/ Contractor from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of the transgression. The severity will be determined by the circumstances of the case, in particular the number of transgressions, the position of the transgressors with the company hierarchy of the Bidder and the amount of the damage. The exclusion will be imposed for a minimum of 6 months and maximum of 3 years.

(3) If the Bidder/ Contractor can prove that he has restored/ recouped the damage caused by him and has installed a suitable corruption prevention system, the Principal may revoke the exclusion prematurely.

(4) A transgression is considered to have occurred if in light of available evidence no reasonable doubt is possible.
Section 4 - Compensation for Damages

1) If the Principal has disqualified the Bidder(s) from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit / Bid Security.

2) If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages of the Contract value or the amount equivalent to Performance Bank Guarantee.

Section 5 - Previous Transgression

1) The Bidder declares that no previous transgressions occurred in the last 3 years with any other Company in any country conforming to the anti corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

2) If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process.

3) Section 6 - Equal treatment of all Bidders / Contractors / subcontractors

(1) The Bidder(s) / Contractor(s) undertake(s) to demand from all subcontractors the commitment consistent with this Integrity Pact, and to submit it to the Principal before contract signing.

(2) The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.

(3) The Principal will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

(4) Section 7 - Criminal charges against violating Bidder(s) / Contractor(s) / Subcontractor(s)

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal
Substantive suspicion in this regard, the Principal will inform the same to the Chief Vigilance Officer.

**Section 8  - Independent External Monitor / Monitors**

(1) The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

(2) The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the Chairman, EPI.

(3) The Bidder(s) / Contractor(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the Principal including that provided by the Contractor. The Contractor will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is application to Subcontractors. The Monitor is under contractual obligation to treat the information and documents of the Bidder(s) / Contractor(s) / Subcontractor(s) with confidentiality.

4) As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or take corrective action, or to take other relevant action. The monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action. However, the independent External Monitor shall give an opportunity to the Bidder/ Contractor to present its case before making its recommendations to the Principal.

5) The Monitor will submit a written report to the Chairman EPI within 8 to 10 weeks from the date of reference or intimation to him by the Principal and
should the occasion arise, submit proposals for correcting problematic situations.

6) Monitor shall be entitled to compensation on the same terms as being extended to / provided to Independent Directors on the EPI Board.

7) If the Monitor has reported to the Chairman EPI, a substantiated suspicion of an offence under relevant IPC / PC Act, and the Chairman EPI has not, within the reasonable time taken visible action to proceed against such offence or reported it to the Chief Vigilance Officer, the Monitor may also transmit this information directly to the Central Vigilance Commissioner.

8) The word “Monitor” would include both singular and plural.

9) Independent External Monitor shall be required to maintain confidentially of the information acquired and gathered during their tenure/ role as independent Monitor. Any breach in this regard would be subject to the legal judicial system of India.

10) Independent External Monitor(s) shall be required to furnish an Undertaking and disclose before taking any assignment that he/ she has no interest in the matter or connected with the party (Bidder/ Contractor) in any manner.

Section 9  - Pact Duration

This Pact begins when both parties have legally signed it. It expires for the Contactor 12 months after the last payment under the contract, and for tall other Bidders 6 months after the contract has been awarded.

If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged / determined by Chairman of EPI.

Section 10  - Other provisions

1) This agreement is subject to Indian Law. Place of performance and jurisdiction is the Registered Office of the Principal, i.e. New Delhi

2) Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.
3) If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

4) Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

___________________   ____________________
(For & On behalf of the Principal)   (For & On behalf of
Bidder / Contractor)

(Office Seal)   (Office Seal)

Place -----------

Date ---------

Witness 1 :

(Name & Address) -------------------------------------------

Witness 2 :

(Name & Address) -------------------------------------------
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGAR, ORISSA

TECHNICAL SPECIFICATION & LIST OF MAKE

CLIENT:

CONSULTANTS:
DDF CONSULTANTS PVT. LTD, NEW DELHI
501, B-9, ITL Twin Tower, Netaji Subhash Place, Pitampura,
New Delhi -110034 Ph: 011-47500600, 47400500 Fax: 01147400555

Special Consultant
Architect Hafeez Contractor
TECHNICAL SPECIFICATIONS
CIVIL WORK
SPECIFICATIONS

1. SPECIFICATIONS FOR EXCAVATION AND EARTHWORK

1.1 SCOPE
The scope of work broadly includes but is not necessarily limited to the following i.e. clearing of the site, excavation of foundation trenches, back-filling, disposal of surplus earth as required including dewatering, shoring and strutting. Contractor shall provide all tools, labour, equipment and incidentals necessary, required for completion of all aspects of work covered in these specifications.

1.2 TYPES OF SOIL
Contractor shall thoroughly acquaint himself with the types of soil in excavation by an inspection of nature of the ground at site.

1.3 CLEARING THE SITE
The site on which the structure is to be built shown on the drawing and the area required for setting out and other operations like road, drains, sheds, etc. should be cleared and all obstructions, loose stones, materials, and rubbish of all kinds, stump, brush wood and trees removed as directed, roots being entirely grubbed up. All useful materials obtained will not be the property of the contractor and will be handed over. Rejected materials will be removed by the contractor to his own dump.

1.4 GROUND LEVELS AND SITE LEVEL PLAN
Before starting the excavations, the requisite block levels of the entire plot shall be taken by the contractor in consultation with the EIC and a proper record of these levels to be kept, which shall be jointly signed by the Contractor and the EIC. A block level plan showing all the ground levels of the plot shall be prepared and shall jointly be signed by the Contractor and the Engineer-in-charge.

1.5 SETTING OUT
After clearing the site, and preparing the site level plan, the Contractor will set out the center lines of the building or other involved works and get the same approved. It shall be the responsibility of the Contractor to install substantial reference marks; bench marks etc. and maintain them as long as required. The Contractor will assume full responsibility for proper setting out, alignment, elevation and dimension of each and all parts of the work.

1.6 EXCAVATION AND PREPARATION OF FOUNDATIONS FOR CONCRETING

1.6.1 GENERAL
Foundation trenches shall be dug wet or dry to the dimensions as shown on the drawings or as directed. The excavated materials shall be stacked at a sufficient distance away from the edge of the excavated pit so as not to endanger the stability of the sides. The soil heap shall not exceed more than 2 m from the ground.

The contractor shall, at his expense and without any extra charge, make provision for all shoring and strutting, extra excavation in slope, extra excavation in working space, dredging or bailing out water, and the excavation shall be kept free from water when the foundation work is in progress.

If excavation is carried out to greater width, length or depth than specified, extra depth shall be made up by filling in lean concrete and extra length or width by filling in with earth rammed hard or by masonry as directed. Cost of such extra excavation and the filling required therein as specified above shall be borne in full by the contractor.

If required to protect the sides of pits and trenches, timber shoring and strutting shall be erected. The timbering shall be closed or open depending on the nature of the soil and work, and arrangement of timbering including sizes and spacing of members used shall be as approved. NO extra charges shall be admissible on this account.
The bottoms of all excavation shall be trimmed and leveled in accordance with drawings / directions. The bottoms of all excavation shall be rammed and wetted before deposition of concrete. The contractors shall report / Engineer-in-charge when the excavation is ready to receive concrete. NO concrete shall be placed in foundations until the contractor has obtained the approval of Engineer-in-charge.

1.6.2 PROTECTION

All foundation trenches and similar excavations shall be strong, fenced and marked with red lights at night for watchmen to avoid accidents.

Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures. All measures required for the safety of the excavation, the people working in and near the foundation trenches, property and the people in the vicinity shall be taken can by the Contractor at his own cost, being entirely responsible for any injury and damage to property caused by his negligence or accident due to his construction operations.

1.6.3 STACKING OF EXCAVATED MATERIALS:

Work for excavation shall include sorting out of useful materials and stacking them on site as directed. Materials suitable and useful for back-filling, plinth, filling, leveling of the plot or other use shall be stacked convenient places, but not in such a way as to obstruct free movement of men, equipment and vehicles or encroach on the area required for constructional purposes.

1.7 BACKFILLING

1.7.1 Earth obtained from excavation (or approved earth brought from out side for which no extra payment shall be made) shall be filled in layers as described in 1.7.3 around the foundations and under floors, In case extra earth used for filling is required under floors, plinth protection including sit outs, courtyards, the contractor will do at their own cost. The lump sum offer shall be deemed to include the earth filing required under floors and plinth protection with plinth height shown in Drawing above the bottom of foundation concrete and finished courtyard level shown in Drawing below D PC /coping level of the main building.

1.7.2 QUALITY OF FILL
Fill shall be of well compacted, well graded earth or sand and shall be free from tree stumps, organic matter, seed and peat etc Where earth or sand from source other than excavation at site is used, the quality of such earth or sand shall be the same as that obtained from excavation at site, or superior to it. Fine sand for filling is River Sand. Black cotton soil shall not be used for back filling or plinth filling.

1.7.3 COMPACTION

The fill shall be spread in layers not exceeding 20 cm thick and each layer shall be watered and thoroughly consolidated by suitable mechanical rollers, rammers, vibrators or other approved plant or system of compaction. The fill material shall be pulverized before depositing in place. An optimum system of compaction. The fill material shall be pulverized before depositing in place. Optimum moisture content shall be maintained for the filled materials. Compaction shall be done so as to achieve a dry density of not less than 90% of the maximum density obtained at optimum moisture content, except for the upper 20 cm layer which shall be compacted to a density of not less than 95% of the maximum density. In order that the fill shall be reasonably uniform throughout, the material shall be dumped in place in approximately horizontal layers “Edge dumping”, a process by which the materials is pushed off edge of the fill and allowed to roll down the slope shall not be carried out. If there is traffic over the fill during construction, either by construction equipment or otherwise, it should be routed to make the compaction as uniform load shall be maintained and also care shall be taken to prevent any wedging action.

1.8 DE-WATERING

Work for excavation shall include bailing or pumping out water which may accumulate in the excavation during the progress of work either form subsoil, seepage, springs, rain or any other cause and diverting surface flow if any by bunds or other means. Pumping out water shall be done in such approved manner as to preclude the
possibility of any damage to the foundation trenches, concrete or masonry of any adjacent structure. When water is met with in foundation trenches, pumping out water shall be from an auxiliary pit of adequate size dug slightly outside the building excavations. The depth of the auxiliary pit shall be more than the working foundation trench levels. The auxiliary pit shall be refilled with approved excavated materials after the de-watering is over.

The excavation shall be kept free from water –

1. When Concrete/Reinforcement work/water proofing work is in the progress.
2. Till the EIC consider that concrete/mortar is sufficiently set.

1.9 SURPLUS EXCAVATED MATERIAL

All excavated material certified as surplus and not useful, shall be removed by the Contractor from the site in an approved manner at his own cost and risk so as indemnify owner from any claims any time of whatsoever nature.

2. SPECIFICATIONS FOR ANTI-TERMITE TREATMENT

2.1 GENERAL

Prevention of termite from reaching the super structure can be achieved by creating a chemical barrier between the ground and the building by treating the soil beneath the building and around the foundations. The work shall be carried out as per IS 6313 part II of 2001 or the latest edition. This shall be provided to sides and bottom of trenches and footings including treating the backfill of foundations up to ground level and the vertical surface of wall, and filling of each under floors and treating the surface at ground level 900 mm around the building.

2.2 MATERIAL

Anti termite treatment, shall be carried out strictly in accordance with CPWD specifications using Chlorophyrifos (CPP) an Emulsified concentrate @ 1% concentration or any other approved chemical.

2.3 PRE-CONSTRUCTION CHEMICAL TREATMENT

This is a process in which chemical treatment is applied to a building in the early stages of its construction at the rate Specified In IS 6313 part II of 2001 or the latest edition. Hand operated pressure pump shall be used for uniform spraying of the chemical. To have proper check for uniform spraying of chemical graduated containers shall be used. Proper check should be kept that specified quantity of chemical is used for the required areas during the operation.

2.4 TIME OF APPLICATION

Soil treatment shall start when foundation trenches and pits are ready to take lean concrete in foundations. Lying of lean concrete shall start when chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub soil water. The foregoing applies also in the case of treatment to the filled earth surface within the plinth before laying the sub grade for the floor.

2.5 DISTURBANCE

The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.
2.6 TREATMENT OF COLUMN PITS AND WALL TRENCHES

a) The bottom surface and the sides (up to a height of above 300 mm) of the excavation made for column pits and trenches shall be treated with the chemical at the rate specified in IS 6313 part II of 2001 or the latest edition.

b) After the column foundation and the wall foundation come up, the back fill in immediate contact with the foundation structure shall be treated at the rate specified in IS 6313 PART OF 2001 or the latest edition of the vertical surface of the substructure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by prodding the earth at 150 mm centers close to the wall surface and spraying the chemical with the above dose. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete to masonry surface of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

c) In the case of R.C.C. framed structure with columns and plinth beams and R.C.C basement with concrete, mix is rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom of excavation for columns and plinth beams. The treatment shall start at the depth of 500 mm below ground level. From this depth the back-fill around the columns, beams and R.C.C. basement wall shall be treated at the rate as per IS 6313 Part II of 2001 or the latest edition. The other details of treatment shall be as laid down in the Clause (b) above.

2.7 TREATEMENT OF TOP SURFACE OF PLINTH FILLING

The top surface of the filled earth within plinth wall shall be treated with chemical emulsion at the rate as per IS 6313 Part II 2001 or the latest direction (surface area) before the sand/sub-grade is laid. Holes up to 50 to 70 mm deep at 150 mm centers both ways shall be made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

2.8 TREATEMENT OF JUNCTION OF WALL AND FLOOR

To achieve continuity of the vertical chemical barrier on inner wall surface from the ground level, small channel 30 X 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel up to ground level 150 mm apart and the chemical emulsion poured along the channel as per rate of application, mentioned in IS 6313 Part II (2001) or the latest edition so as to soak the soil right up to bottom. The soil shall be tamped back into place after this operation.

2.9 TREATEMENT OF SOIL ALONG EXTERNAL PERMIETER OF BUILDING

During progress of work, provide hole in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and depth 300 mm and filling these holes with chemical emulsion at the rate (as per IS 6313 Part II of 2001 or the latest edition) per meter of perimeter of the external wall.

2.10 TREATMENT FOR EXPANSION JOINTS

Anti termite treatment shall be supplemented by treating through the expansion joint after the sub grade has been laid as per IS 6313 Part II of 2001 or the latest edition.

2.11 TREATMENT OF SOIL SURROUNDING PIPES AND CONDUITS

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe, or conduit for a distance of 150 mm and up to depth of 75 mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75 mm for distance of over 300 mm from ground level.

2.12 SAFETY PRECAUTIONS

All chemicals used for anti-termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapors or spray mists or swallowed.
Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below.

These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labeled and should be stored carefully so that children and pets cannot get at them. They should be kept securely closed.

Special care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water, especially before eating or smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water, if chemicals splash into the eyes they should be flushed with plenty of fresh water and immediate medical attention should be sought.

The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed nearby during the mixing. Care should be taken in the applications and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed nearby during the mixing. Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.13 GUARANTEE

The contractor shall guarantee through a guarantee bond, the anti-termite work for 10 years from the date of completion of the project, and shall indemnify the Engineer-in-charge against any defects that arise therein during the guarantee period as aforesaid. They shall immediately rectify, any defects that may occur therein, and repair all other damage occurring to any part of the structure on account of defect in Anti-termite treatment, during the guarantee period of aforesaid.

3. SPECIFICATION FOR CAST – IN – SITU REINFORCED CEMENT CONCRETE

3.1 GENERAL

3.1.1 DESCRIPTION

This section covers the requirements for finishing of cement concrete, proportioning, batching, mixing, testing, placing, compacting, finishing, jointing, curing and all other work as required for cast in place reinforced concrete. The contractor shall provide all the materials including cement, steel, labour, equipment, ‘form work’, scaffolding etc., required for completion of all reinforced concrete works as per drawings and documents. Cement concrete shall be composed of cement, fine aggregate, coarse aggregate, water, with or without admixture as approved, proportioned and mixed as specified herein.

3.1.2 RELATED WORK SPECIFIED ELSEWHERE

a) Steel reinforcement
b) Form work

3.1.3 APPLICABLE CODES AND STANDARDS

The codes and standards generally applicable to the work of this section are listed hereinafter.

IS 383 Coarse and fine aggregates from natural sources for concrete
IS 456 Code of practice for plain and reinforced concrete
IS 516 Methods of testing for strength of concrete?
IS 1199 Methods of sampling and analysis of concrete
IS 1489 Portland - Pozzolana cement
IS 1838 Perform fillers for expansion joints in concrete non-extruding and resilient type
IS 1946 Code of practice for use of fixing devices in walls, Ceiling and floors of solid construction
IS 2389 Methods of testing of aggregate for concrete’s
IS 2505 Concrete vibrators, immersion type
IS 2645 Integral cement water proofing compounds
IS 3414 Code of practice for design and installation of joints in buildings
IS 3558 Code of practice for use for immersion vibrators for consolidating concrete
IS 4082 Recommendation on stacking and storage of construction materials at
IS 7861 Code of practice for extreme weather concreting
IS 7861 Recommended practice for hot weather (part I) concreting
IS 8112 Ordinary Portland Cement grade 43
IS 12269 Ordinary Portland Cement grade 53

PART—I

The following clauses are intended to amplify the requirements of the reference document listed above and the contractor shall comply with these clauses

3.2 SUBMITTALS

3.2.1 Material Report
3.2.2 Prior to start of delivery of materials required, the following shall be submitted by the contractor to the Engineer-in-charge for approval.

Suppliers and / or sources of all consumable materials including cement, steel, fine and coarse aggregates, water additives, bricks and timber etc.

Quality Inspection Plan to ensure continuing quality control of ingredients by periodic sampling, testing and reporting of the quality of materials being supplied.

3.3 PLANT AND EQUIPMENT

The contractor shall submit the following well in advance.

The proposed program, methods and details of plant and Equipment for be used to testing of ingredients and concrete samples.

The proposed programme methods and details of plant & equipment to be used for concrete work.

3.4 REPORTS FOR INSPECTION AND TESTING

During concreting operations, the contractor shall conduct inspection and testing as described under the list of mandatory tests in this volume and all reports thereon shall be submitted in summary form.

3.5 SCHEDULES

Before commencement of the work the contractor shall prepare working schedules of concreting giving dates and rate of pour for each item of work and submit the same for approval.

3.6 MATERIALS

Before bringing to the site, all materials for cement concrete shall be approved. All approved samples shall be deposited in the office of the Engineer-in charge before placing orders for the materials with suppliers The materials brought on to the work shall conform in every respect to their approved samples.

Fresh samples shall be deposited whenever type or source of any material changes. The contractor shall check each fresh consignment of materials as it is brought on to the works to ensure that they conform to the specification or approved samples. Any of the materials can be tested to find whether they are in accordance with specifications at the contractor’s expense. All bills vouchers and test certificates which are necessary to convince the quality of materials or their suitability shall be produced for inspection when required.
Any materials which have not been found to the specification and not approved by shall be rejected forthwith and shall be removed from the site by the Contractor’s at his own cost within the time stipulated. EIC have the powers to cause the contractors to purchase and use materials from any particular source, as May in their opinion be necessary for the proper execution of work.

3.6.1 CEMENT

Cement shall be provided by the Contractor.

On the following types of cement as specified shall be used

a. Ordinary Portland Cement 43 grade confirming to BIS 8112-1987
b. Ordinary Portland Cement 53 grade confirming to BIS 12269-1987
c. Portland Slag Cement conforming to IS 455.
d. Portland Pozzolona cement (fly ash based) conforming to IS 1489 (Part- 1)

If the cost of actual cement used (from a to d) is lower than other types of cement (from a to d) then the differential amount shall be adjusted from the contractor’s bill

Cement at site shall be stored in dry weather proof go-downs (or shed) built by the Contractor at his own costs in stacks which are not higher than 10 bags. The cement go-down shall be constructed as per CPWD specifications. The contractor shall conduct all necessary tests as specified in the IS code of the cement supplied at the contractor’s cost to ascertain himself on quality of the material issued.

3.6.2 AGGREGATES

a) Aggregates from natural sources shall be in accordance with IS: 383. The contractor shall submit certificates of grading and compliance from the suppliers for all consignments of aggregate. In addition at site from time to time, the contractor shall test the aggregates in accordance with IS: 2386 parts 1, II, III and IV. The contractor shall allow for and provide all necessary apparatus for carrying out each test and for supplying test records.

b) For fair faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities which may cause discoloration.

c) The fine aggregates shall be river sand, stone dust or other approved sand. It shall be free from clay, loan, earth or vegetables matter and from salt or other harmful chemical impurities It shall be dean sharp, strong angular and composed of hard siliceous material.

The grading of sand as determined by the method prescribed in IS: 2386 part I shall be within the limits of grading zone III given in Table 1. When the grading falls outside the percentage limits given for sieves other than 600 micron, 300 micron, and 150 micron (IS) sieves by not more 5 percent, it shall be regarded as falling within this zone. The 5 percent can be excess submission on one more sieves.

**TABLE 1**

FINE AGGREGATE

<table>
<thead>
<tr>
<th>I. S. Sieve</th>
<th>ZONEI</th>
<th>ZONEII</th>
<th>ZONEIII</th>
<th>ZONE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90-95</td>
<td>90-100</td>
<td>90-100</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
<td>75-100</td>
<td>85-100</td>
<td>95-100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
<td>55-90</td>
<td>75-100</td>
<td>90-100</td>
</tr>
<tr>
<td>600 micron</td>
<td>15-34</td>
<td>35-59</td>
<td>35-60</td>
<td>80-100</td>
</tr>
<tr>
<td>300 micron</td>
<td>5-20</td>
<td>8-30</td>
<td>8-30</td>
<td>20-65</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-10</td>
<td>0-10</td>
<td>0-10</td>
<td>0-15</td>
</tr>
</tbody>
</table>
The maximum quantity of silt as determined by the method prescribed in IS: 2386 Part II shall not exceed 8%. Stone dust shall be within the limits of Grading Zone III given in table 1. When the grading falls outside the percentage limits given for the sieves other than 600 micron and 300 micron (IS) sieves by not more than 5 percent and on 150 micron sieves by not more than 20 percent it shall be regarded as falling within this zone. The 5 percent can be excess summation on one or more sieves.

3.6.2.1 COARSE AGGREGATE

The coarse aggregate shall be crushed stone or broken stone. Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable clean and free from soft, friable, thin, flat, elongated flaky pieces. The coarse aggregate should be from the approved source/quarry.

Coarse aggregate River shingle or pit gravel shall be rounded, sound hard, clean, non porous, suitably graded in size with or without broken fragments and free from flat particle of shale, clay, silt, loam and other impurities.

Except where it can be shown to the satisfaction, a supply of properly graded aggregate of uniform quality can be maintained over the period of obtaining the coarse aggregate in different sizes & blending them in correct proportions as and when required.

The maximum size of coarse aggregate shall be such that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of form work.

3.6.3 WATER

Water used in the works shall be potable water and free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and/or washing aggregate shall be fresh and clean, free from injurious amounts of oil, salts, acids, alkali, other chemicals and organic matter.

Water shall be from the source approved and shall be in accordance with Clause 4.3 of IS: 456.

Before starting any concreting work and whenever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete. No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the contractor.

3.6.4 ADMIXTURES AND ADDITIVES

Chemical admixtures are not to be used until in case their use is permitted, the type, amount and method of use of any admixture proposed by the contractor shall be submitted for approval.

The contractor shall further provide the following information concerning each admixture.

a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.

b) The chemical names of the main ingredients in the admixture.

c) The chloride ion content, if any, expressed as a percentage by weight of admixture.

d) Whether or not the admixture leads to the entrapment of air when used in the manufacturer’s recommended dosage.

e) Where two or more admixtures are proposed to be used in any one mix, the manufacturer’s written confirmation of their compatibility.

In reinforced concrete, the chloride ion of any admixture as determined in accordance with IS: 6925 and the total chloride ion in all admixtures used in concrete mix shall not exceed 0.30\% by weight of cement.

The admixtures when used shall conform to IS: 9103. The suitability of all admixtures shall be verified by trial mixes.

The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.

Regarding admixtures when used shall be based on lingo-sulphonates with due consideration to clause 5.2 and 5.30 of IS: 7861.
3.7 PLANT
The contractor shall obtain the approval of the Engineer-in-charge for all plant items he proposes to use for the manufacture and placing of concrete.
The arrangement shall maintain all items of plant at all times in a clean and efficient working condition.

3.8 STORAGE
All goods and products covered by these specifications shall be procured well in advance and stored as specified below.

3.8.1 CEMENT
Cement shall be stored on a raised floor in dry weather proof & dust free but well ventilated shed.

Cement bags shall be stacked close together away from external walls and in stacks of not more than ten bags to avoid lumping under pressure.

Cement stored during monsoons or cement expected to be in store for more than eight weeks shall be completely enclosed in 700 micron polyethylene sheet so arranged that the flap closes on the top stack. The contractor shall ensure that protective polyethylene sheet is not damaged at any time during use.

Consignments of cement shall be used in order of delivery A record shall be kept of the batch numbers of cement deliveries in such a form that the part of the works in which the cement is used can be readily identified. If during delivery or by test, the cement is found to be defective, the same shall be returned back forthwith.
The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.

Cement stored on site for a period longer than eight weeks shall be tested to the satisfaction of the Engineer in-charge before it is used in the works. Cement that has failed the tests conducted shall not be used in the works and shall be remarked from the site immediate by without fail.

3.8.2 STORING OF AGGREGATE
Aggregates shall be stored on a suitable well drained raft of concrete, timber, metal or other approved material. The storage of aggregates on the ground will not be permitted.

Each size of aggregate shall be stored separately in such a manner as to prevent spillage and mixing of one aggregate with an adjacent aggregate The dividing walls of any bin shall be of sufficient height and the aggregate shall be so deposited that a distance of 100 mm shall be left between the top of the division wall and any part of the aggregate stack.

When stack piling, the aggregate shall not form pyramids resulting in segregation of different size particles. The stacks shall be regular and of a height not exceeding two meters.

3.9 Grades of Concrete
The grades of concrete shall be in accordance with the following table. The grade of concrete to be used in each section of work will be shown in the drawings or in the Bill of Quantities:

Waterproofing admixtures shall comply with IS: 2645.
CHARACTERISTIC STRENGTH

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Grade of Concrete Characteristic strength i.e., compressive strength of 15 cm. Cubes at 28 days (N/mm²)</th>
<th>Nominal maximum aggregate size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>20</td>
</tr>
</tbody>
</table>

Unless otherwise specified in the drawings, the maximum nominal size of coarse aggregates for different grades of concrete shall be as under:

a) For concreting in very narrow space or in very small thickness 12 mm  
b) For all reinforced concrete work except in massive foundations 20 mm  
c) For all ordinary plain concrete and massive reinforced foundations 10 mm

All mix design grades viz., M10, M15, M20, M25, M30 etc., shall be designed and have a minimum cement content as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Qty (in kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-10</td>
<td>220</td>
</tr>
<tr>
<td>M-15</td>
<td>240</td>
</tr>
<tr>
<td>M-20</td>
<td>310</td>
</tr>
<tr>
<td>M-25</td>
<td>330</td>
</tr>
<tr>
<td>M-30</td>
<td>340</td>
</tr>
</tbody>
</table>

Minimum content of cement remaining unchanged, as specified above for each type of concrete mix, the proportion and quantities of local sand and aggregate are to be worked out and determined in the field/laboratory as per Road Research Note No.4, Department of Scientific and Industrial Research, United Kingdom for design of concrete mixes or as per ACI 613 with the approval of the Engineer. Any change in the source of aggregates will require the re-designing of the concrete mix for the Engineer’s approval.

3.10 Mix Design

General  
At the commencement of the contract, the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of the Engineer to such proportions before start of concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing table.
No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written authorization for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is being carried out according to the approved proportions. For the major and important RC works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to relevant I.S. codes or to approved standard methods.

The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

3.11 Water/Cement Ratio

Where a particular water/cement ratio is stipulated in the design or drawing along with the characteristic grade of concrete, the design of mix shall be carried out by adjusting the other variable factors to obtain characteristic strength of concrete with stipulated water/cement ratio.

In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements, underground premises, tunnels, pump houses, exposed structures near sea side or deserts, pre-stressed structure, thin precast members etc., the water/cement ratio shall be kept low and preferably not exceeding 0.45.

The water cement ratio as achieved in the mix design or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

3.12 Workability

The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling and lacing so that after compaction, it becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. During the finalization of trial mixes, the relationship between compacting factor and slump test shall be established for each grade of concrete as well as for various levels for workability.

Normally, in the condition of low water cement ratio as well as for medium/high workability, the Workability shall be achieved by increasing the cement content.

In cases where the cement content is to be limited to reduce the heat of hydration, and the water / Cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired Workability may be achieved with the use of limited doses of plasticizer or air entraining agent. In such cases, the method of mixing and dosage of the plasticizer / air entraining agent shall be according to the Manufacturer’s specification and with the approval of the Engineer.

Consistency and workability of concrete shall be checked by measuring the slump of a truncated cone of concrete straight from the mixer under normal working conditions. The conical mould shall be of metal, 300 mm high and 100 mm and 200 mm in diameter at top and base respectively.

Moulds shall be prepared by the Contractor. The slump range of concrete shall be as per the tabulation given below, as well as standards.

Slump tests shall be performed as per IS:1881 at intervals established by the Engineer at the Contractor's cost in such a Way as to check that the degree of consistency established by the Engineer for work in progress is maintained. The table below gives the general slump range to be followed for various types of construction unless otherwise shown on drawings or instructed by the Engineer.
3.7(b). The concrete mix will be designed for minimum workability as per the table given below:

<table>
<thead>
<tr>
<th>Placing conditions</th>
<th>Degree of workability</th>
<th>Slump (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightly reinforced sections in slabs, beams, walls and columns</td>
<td>Low</td>
<td>25 – 75</td>
</tr>
<tr>
<td>Heavily reinforced section in slabs beams, walls and columns</td>
<td>Medium</td>
<td>50 - 100</td>
</tr>
<tr>
<td>Pumped concrete</td>
<td>Medium</td>
<td>75 - 100</td>
</tr>
</tbody>
</table>

3.13 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water/cement ratio and Appendix A of IS: 456 shall be taken as guideline for durability considerations.

3.14 Trial Mixes

After approval of the mix design by the Engineer, the Contractor shall make in presence of the Engineer the trial mixes for each grade of concrete as well as for required workability.

Before starting the trial mixes, necessary preparatory works like determination of sieve analysis of the aggregates, densities of different ingredients, moisture contents in the aggregates, shall be completed according to the relevant BIS Codes.

Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

Five (5) 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant BIS codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the design mix shall have higher average compressive strength depending on the degree of quality of control at site.

Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and subsequent testing of the test cubes obtained there from and the desire of the approved mix for that particular grade of concrete.

The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.
3.15 Nominal Mix Concrete
Nominal mix concrete may be used for all concrete of grade M-10 and below. If design mix concrete cannot be used for any reason for grade M-15 and M-20, nominal mix concrete may be used with the permission of the Engineer. Nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of IS 456. The stipulations of clauses 8.3.1 and 8.3.2 of IS: 456 shall also be taken into consideration.

3.16 Volumetric Mix Concrete
Where concrete is specified in volumetric proportions such as 1:4:8, 1:3:6, 1:2:4, 1:1.5:3, 1:1:2 etc., in the Bill of Quantities, coarse & fine aggregates shall be measured by volume & cement by weight. The water cement ratio shall be within 0.45 & 0.70 depending upon the workability.

3.17 Batching of Concrete

3.17.1 Cement
Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, a number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly.

3.17.2 Aggregates
For both design mix concrete and nominal mix concrete, the aggregates,(coarse and fine) shall be batched by weight. In particular cases, or where weight-batching is not possible, proportioning by volume batching may be allowed by the aggregates throughout the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be bulking in accordance with IS (Part III). Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.

3.18 Water

3.18.1 General
Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank filled to the mixer.

3.18.2 Adjustment of Water Due to Moisture Contents in Coarse and Fine Aggregates
It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of the amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be checked as frequently as possible, the frequency for a given job being determined by the Engineer according to weather condition.

3.18.3 Determination of Moisture Content in the Aggregates
Determination of moisture content in the aggregates shall be according to IS 2386 (Part-III). Where tests are not conducted, the amount of surface water may be estimated from the following table:

<table>
<thead>
<tr>
<th>Aggregates</th>
<th>Surface water Carried by Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% by weight</td>
</tr>
<tr>
<td>Very wet sand</td>
<td>7.50</td>
</tr>
<tr>
<td>Moderately wet sand</td>
<td>5.00</td>
</tr>
<tr>
<td>Moist San</td>
<td>2.50</td>
</tr>
</tbody>
</table>
3.18.4 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi-liquid admixture may be measured by weight or volume.

The Bidder shall indicate the brand name, the Manufacturer and the properties of any admixture to be used for the concrete as per Bill of Quantity items or on his own initiative.

3.18.5 Accuracy of Batching

The accuracy of batching shall be within the following tolerance:

1. Cement within + 2% by weight
2. Aggregate within + 5% by weight
3. Water within + 0.5% by weight.

3.19 Mixing of Concrete

3.19.1 Machine Mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for at least one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in color and consistency. The mixing time from the time of adding water shall be in accordance with IS 1791, but in no case less than 2 minutes or at least 40 revolutions.

3.19.2 Hand Mixing

When hand mixing is permitted by the Engineer, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case, of hand mixing, 10% extra cement shall be added to each batch at no extra cost.

3.20 Transportation of Concrete

Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by any means, which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily identifiable at the place of final deposit.

3.21 Preparatory Works/Surface Preparation

3.21.1 For Concrete Directly on Earth Foundation

Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without extra cost. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.
The earth foundation, over which concrete is to be placed directly, shall not be kept abandon at the specified level and concrete shall be placed immediately following otherwise suitable measures shall be taken, as directed by the Engineer without extra cost ...

3.21.2 For Construction Joints

Concrete shall be cast, as far as possible, continuously until the parts of structure to be built are finished. Should this not be feasible, the type, number and location of construction joints shall be approved by the Engineer prior to placing concrete.

All such joints shall have continuous square bond grooves to produce substantial and water-tight-key and the exposed faces of joints shall be monolithic with the main mass of concrete formed and completed under substantially shattered faces. The Contractor shall take all the necessary steps by means of timber edgings etc. to ensure an exact horizontal straight finish to outside edge of any lift of concrete. Subject to the approval of the Engineer, the Contractor is at liberty to arrange his own construction joints but the following restrictions are to be observed:

1. There shall be no vertical construction joints

2. No longitudinal joints shall be made in the walls and floors of trenches and pits unless otherwise shown in the drawings.

3. Concrete pouring shall be reasonably large, but in no case shall the height of pouring concrete exceed 1.5 m without the Engineer's firm approval. Such approval of the Engineer shall not in any way relieve the Contractor of his responsibility to ensure that the construction is water tight and that no segregation takes place.

4. Laitance shall be removed from the surface of concrete before it has set hard by washing and wire brushing so as to expose the stones of the top layer without undue erosion of the mortar or damage to the under laying concrete.

All beds and joints in concrete faces, which have become set, are to be picked all over and all loose materials removed before fresh concrete is deposited thereon. The indentations shall be at least 12 mm deep and not less than seventy five percent of the area of the existing concrete face to be covered over.

Immediately before depositing fresh concrete, the exposed surface shall be cleaned of foreign matter by further wire brushing, if necessary. It shall then be thoroughly washed and surplus water removed. The surface, while still moist, shall be covered with layer of 1:1 cement mortar which must be vigorously stippled into the surface by means of a stiff brush, the depositing of the fresh concrete following on closely. Pockets to form keys shall be left in the surface of the concrete at constructional joints, 75 mm deep and approximately equal to 20% of the exposed surface.

All costs in connection with the forming of construction joints shall be to the account of the Contractor and shall be deemed to be included in the rates for concreting and formwork and shall not be separately paid for. In a column, the joint shall be formed 75 mm below the lowest soffits of the beams, including haunches, if any.

Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable, then the joint shall be vertical and at the centre of, or within, middle third of the span, unless otherwise shown on the drawings.

3.21.3 On Vertical Surfaces of Masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of dimension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be cleaned thoroughly. Before the placement of concrete,
the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

3.21.4 Inside the Form Works (Cleaning, Surface Preparation etc.)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from the dirt’s, grease/oil foreign and deleterious materials etc. The reinforcements shall be completely cleaned and free from all sorts of dirt’s grease/oil, rust, foreign/deleterious materials etc. Before placement of concrete, the form works coming in contact with concrete, shall be coated highly with form oil or raw linseed oily material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be taken so that such oily material does not come in contact with the reinforcement.

3.22 Placing and Compaction of Concrete

Before placing the concrete, the Contractor shall ensure that:

1. All mixing and placing equipment is thoroughly cleaned
2. All concreting space is free from debris and rubbish
3. All forms have been thoroughly wetted or oiled and firmly installed in line and plumb to the Engineer's approval.
4. All reinforcement is cleaned of loose rust, scales and other injurious adherents and is firmly bound and correctly placed and has been so approved by the Engineer.
5. All inserts, sleeves, foundation bolts and embedded parts have been correctly and firmly installed to conform to the Engineer's drawings and have been carefully checked to comply with the drawings. Special care shall be taken to locate and check sleeves or inserts, which may not be symmetrically placed with respect to centre lines.

The Contractor and Engineer shall separately inspect and check the above mentioned points and record and sign the results in a register which shall be maintained by the Contractor in a approved form. No concrete shall be placed without the Engineer having inspected and approved in writing. In spite of ensuring the above requirements, the Contractor shall fill pour cards furnishing the necessary details of the job, duly signed by the Engineer. This, however, will not absolve the Contractor from his responsibility to correctly execute the work. Pour cards shall contain the following information:

Design Index
- Date
- Slump
- Workability
- Work test specimen
- Type of finishing and admixtures used (if any)
- Period of removal of shuttering/props/forms.

a) The concrete pouring method shall be submitted to the Engineer for approval and shall always be such as to avoid any possibility of segregation of the components or shifting of the reinforcement.
b) Special grout or mix shall be used for difficult and intricate locations as specified by the Engineer. During placing, the concrete shall be thoroughly worked around reinforcement, embedded parts and corners of the formwork.
c) Greatest possible care shall be taken by the Contractor that reinforcement and embedded parts, particularly foundation bolts and sleeves are not displaced during placement of concrete. While concreting mats and other such locations where top and bottom reinforcement are adopted, top reinforcement shall be thoroughly cleaned of all slurry and mortar sticking to them at the time of concreting top layers.
d) The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be non vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer, all inserts and
embedment properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.
e) Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. See page water, if any, shall be controlled or diverted.
f) Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete.
g) Where plums are permitted in massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.
h) Concrete shall not be dropped from a height of more than 2 m except through a chute, the design and type of which shall be subjected to approval of the Engineer.
i) The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.
j) For members involving vertical placing of concrete (e.g., columns, walls etc.), each lift shall be deposited in horizontal layer extending for the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction being employed.
k) For members involving horizontal placing of concrete (e.g., slabs, beams etc.), the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line vibration and surface finish shall follow behind the placement as closely as possible.
l) Utmost care shall be taken to avoid the displacement of reinforcements/ embedded parts or movement of form work or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.
m) All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete, which is still plastic and workable. n. Should any unforeseen occurrence result in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor.
n) The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedment, holes, openings etc, well within the accepted tolerance limit.

3.23 Construction Joints

Normally, the construction joints including crack inducing joints shall be constructed as per locations and details indicated on the drawings. Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guidelines. In all construction joints, the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

a) In Columns

i) In case of Projection from Basement Slab, 300 mm from the top of base slab or 75mm from the top of the haunches whichever is higher.

ii) In framing the beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the tope surface of the beam/slab or at the top surface of beam/slab whichever facilities formwork.

iii) For columns below flat slabs, 75 mm below the lowest soffit of the slab.

b) In Walls (Horizontal Construction Joints)

i) For Walls Projecting from Base Slab, 300 mm from top of base slab.
ii) For Walls supporting the suspended slab, 75 mm from the lowest soffit of the slab.

Note: In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely watertight.

c) In Beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joints from simply supported beam shall be vertical and at the middle of the span; in continuous beam, the same shall be at the point of minimum shear force.

d) In Suspended Slabs

i) In slab of small span, there shall be reconstruction joints.

ii) In slabs of large span and continuous slabs, the Construction joint, if allowed by the Engineer, shall be vertical at the middle of span and at right angles to the principal reinforcement.

e) In Walls (Vertical Construction Joint)

As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force.

f) In Slabs Resting on Ground

i) For Plain Concrete

Concreting shall be done in alternate panels not exceeding 10 m² in area. The largest panel Dimension shall be 5 m.

ii) For Nominally Reinforced Slab

The area of pour shall not exceed 40m² and the maximum panel dimension shall not exceed 8m.

iii) For the Basement Slabs Which Act as Structural Member

These shall be no construction joint.

g) In Ribbed Beams

The beams shall be monolithically with the slab in one continuous operation.

3.24 Cold Joints

An advancing face of pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it:

1. If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete along with the old concrete shall be vibrated systematically and thoroughly.

2. In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on one cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly penetrating deep into the layer of concrete.

3. In case the concrete at the joint has become so stiff that it cannot be remolded and mortar or slurry does not rise in spite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these Specifications.

3.25 Sub-standard concrete

Should the work strength of controlled concrete fall below the specified strength, Engineer shall decide:
1. To reject the work, in which case the Contractor shall replace the defective work with concrete of required strength and bear all costs for dismantling and replacing including cost of associated form work, reinforcement, embedded parts & all associated works.

2. To accept the work at a reduced rate, in which case the unit rate payable for sub-standard work will be reduced by ..., directly in proportion to the work strength as compared to the specified strength. The Engineer may, in addition, require other tests performed on the respective structural member so accepted period to its acceptance with or without necessary corrective measures and in each such case, the Contractor shall bear all costs for all such tests or corrective measures, besides the reduction in the unit rates as specified herein.

3. Concrete of strength below fifteen (15) percent of the specified strength will not be accepted.

4. The test load shall be 125% of the maximum superimposed load for which the structure was designed. Such test load shall not be applied before 56 days after the effective hardening of concrete. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.

5. If, within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not at least 75% of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer, the cost of the load test shall be borne by the Contractor.

### 3.24 Optional Tests

The Engineer, if he so desires, may order tests to be carried out on cement, sand, coarse aggregate, water in accordance with the relevant Indian Standards.

**Tests on cement shall include**

1. Fineness test
2. Test for normal consistency
3. Test for setting time
4. Test for soundness
5. Test for tensile strength
6. Test for compressive strength
7. Test for heat of hydration (by experiment and by calculation) in accordance with IS: 269.

**Tests on sand shall include**

1. Sieve test.
2. Test for organic impurities.
3. Decantation test for determining clay and silt content.
4. Specific gravity test.
5. Test for unit weight and bulk age factor.
6. Test for sieve analysis and fineness modulus.

**Tests on coarse aggregates shall include**

1. Sieve analysis.
2. Specific gravity and unit weight of dry, loose and rodded aggregate.
3. Soundness and alkali aggregate reactivity.
4. Petrographic examination.
5. Deleterious materials and organic impurities.
6. Test for aggregate crushing value.

Any or all these tests would normally be ordered to be carried out only if the Engineer feels the materials are not in accordance with the specifications or if the specified concrete strengths are not obtained and shall be performed by the Contractor or at an approved test laboratory at the cost of the Contractor.

If the work cubes do not give the stipulated strengths, the Engineer reserves the right to ask the Contractor to dismantle such portions of the work which, in his opinion, are unacceptable and re-do the work to standards stipulated, at the Contractor's cost. The unit rate for concrete shall be all inclusive, including making preliminary mix design and test cubes works, cubes, testing them as per specification, slump tests, optional tests etc.,

### 3.27 Concrete for Equipment or steel structures foundations
Concrete for equipment foundation, whether principal or auxiliary, shall be poured continuously so that the structure becomes monolithic, particular care being exercised to see that the base slabs, if any, are of compact impervious construction. Tunnels, passages, apertures and so forth shall be provided in accordance with the drawings for the installation of mechanical and electrical equipment, pipes or cables. The top elevation of the equipment foundations or parts shall be accurately cast to 20/50 mm (or more as may be specified on the drawings) above the level required for grouting and it shall be pneumatically chiseled off and well roughened just prior to the erection of the equipment concerned. All embedded anchor bolts or bolt sleeves shall be accurately and firmly set with the aid of approved templates, steel supports and/or other accessories. For holding the embedded bolts or sleeves in the correct position during concreting, template shall have to be of steel of suitable section approved by the Engineer. Two sets of templates shall have to provided, one to hold the bottom and the other the top of the bolts or sleeves. The bottom template shall be securely and rigidly fixed by providing anchorage arrangement and by welding to the lowest part of the steel reinforcement and other structural supports. The top templates shall be securely fixed by tying with guy wires and turn buckle arrangements to firm and rigid adjoining structures and staging. The bottom template that is embedded in concrete will be measured and paid for as embedded steel.

Bolt pockets, where required, shall be cast with wooden taper wedges. These shall be withdrawn at an appropriate time when the concrete has set, the pockets cleaned, roughened and then covered or blocked thoroughly to prevent debris getting into these. The exposed portions of bolts and embedded parts shall be kept well greased and adequately protected from damage throughout construction. Any damages found shall have to be corrected at the Contractor's cost .. shall have the right to use the foundations, pads, piers, slabs, floors and all concrete work as needed for other works  or equipment erected prior to its "Taking Over".

3.28 Requirements for Concreting in Special Cases

3.28.1 Concreting in Deep Lifts

Placing of concrete in lifts exceeding 3 m in columns and 2 m in walls is in the category of deep lifts. Before commencement of work, the Contractor shall submit for the approval of the Engineer, the details of the methods he proposes to adopt for concreting. The placement of concrete shall preferably be by tremie chute or any other approved method.

In structures of heavy/complicated reinforcement or in complicated form works, the Contractor shall provide sufficient number of windows in the form works as directed by the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

3.28.2 Concreting Under Water

The mix and method of concrete to be placed under water shall be approved by the Engineer. Under water, concrete shall contain at least ten (10) per cent more cement over that required for normal placement.

An account of extra cement so used shall be maintained by the Contractor and the Engineer jointly and the extra cement used shall be separately paid for. Plumbing of water shall not be permitted for twenty four (24) hours after completion of placement. No flow of water, natural or artificial, shall be permitted during placement and up to twenty four (24) hours after completion of placement.

3.28.3 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 4.5°C or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II).

3.28.4 Hot Weather Concreting
Concrete shall not normally be placed when the atmospheric temperature exceeds 40°C in the open. If, in spite of programming concrete work in the cooler hours of early morning, evening or night, placement is necessary in too hot a weather, then the Contractor shall take at least the following additional precautions:

1. Stock-pile aggregates in shade
2. Do not use fresh, factory hot cement
3. Use cold water
4. Cool form work by sprinkling water without collecting water inside
5. Reduce to minimum the time interval between mixing and placing
6. Place, vibrate and finish as quickly as possible
7. Initiate curing as soon as concrete hardens.

Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

3.28.5 Concreting in Large Pours (Mass Concrete)

The aim of controlling the concreting in large pours is to reduce cracking caused by shrinkage due to heat of hydration. The Contractor shall submit detailed proposal to the Engineer for approval about the method of pouring and the measures to reduce heat of hydration, which he proposes to adopt. The maximum height of lifts will depend on the type of cement used. The use of cement having lower heat of hydration, could allow greater lifts. The Contractor shall provide all the necessary arrangements like pre-cooling of aggregates, cooling of fresh concreting by passing cold water through pipes placed inside the concrete or such other measures at least 38 hours before the placement of concrete and also provide the facility for recording of temperature at least 24 hours prior to placement of concrete. The minimum interval between concreting of successive lifts, separated by horizontal construction joint, shall be six days or as directed by the Engineer.

The minimum interval between the concreting of adjacent pours separated by vertical construction joints shall be three (3) days, or as directed by the Engineer.

3.29 Finishes to Exposed Surface of Concrete

The Contractor is to include his quoted rate for concrete, the provision of normal finishes in both formed and unformed surfaces as and where required by the Engineer without any extra cost. Some common finishes are indicated below:

3.29.1 Surfaces which do not require Plastering

Surface in contact with casing shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centering, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if in the opinion of the Engineer, such plastering is unavoidable, then the thickness of plaster shall in no case exceed 5 mm and the plastering shall be in CM (1:3).

3.29.2 Faces of Foundations which will be Back Filled

Neither the smoothness of the surface nor the positions of the joints in the form work are important. Small blemishes caused by entrapped air are permitted. No special surface finish is required.

3.29.3 Exposed Surfaces

Surface of beams/columns flushing with the block work or other structures where it is intended to plaster, shall be backed adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

3.29.4 Surface for Non-integral Finish
Where a non integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels shall be furnished and finished rough.

3.29.5 For Monolithic Finish

Where no more finishing course is to be supplied as in the case of basement floor, industrial flooring or the screed concrete flooring etc., the concrete shall be completed and struck off at the specified levels and slopes in a screed board and then floated with a wooden float. Steel troweling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface but not hard enough to prevent proper finishing. Trowelling shall be such that the surface is flat, smooth and neatly finished.

3.30 Curing of Concrete

3.30.1 General

The purpose of curing is either to provide sufficient water at optimum temperature or to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which, of course, is a slow and prolonged process. As soon as the concrete has hardened sufficiently, the curing shall be started.

3.30.2 Different Methods of Curing

Any one of the following may be used for curing as approved by the Engineer.

a) Curing by Direct Water

This is done either by pounding or spraying water.

Pounding
Pounding is widely used for curing slabs and pavement. Earth bands are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

By Spraying Water Curing is done by spraying water by suitable means at approved time intervals. While spraying, it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternative wetting and over drying shall be avoided.

Curing by spraying water shall be continued as least for 18 days.

b) Curing of Concrete with Absorbent Material Kept Damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for at least 12 days after final settings.

b) Curing by Covering Concrete Surface with an Impressive Sheet

This is achieved by covering the entire concrete surface with water proof paper or plastic sheets specially manufactured for this purpose. The waterproof papers are stuck together by adhesive compound and the plastic sheets can be welded at site. Such type of covering shall be kept at least for 24 days after the final setting. It is preferable to have sheet as white in appearance since the white colour will reflect hot sunrays and keep the concrete temperature at reasonable level.

c) Curing by Providing Protective Membrane by Applying curing compound

This is achieved by applying a membrane forming compound (curing compound) over the concrete surface. Generally, these are available in the emulsion form. The application of the curing compound should be started immediately after stripping off the shuttering in case of formed surface and after the surface has hardened in case of unformed surface.
The curing compound membrane forming emulsions dry up within 3 to 4 hours after application and forms a continuous coherent adhesive membrane over the concrete surface. Such membrane serves as a physical barrier to prevent the loss of moisture from the concrete itself. Membrane forming emulsions are generally coloured black or white to improve Visibility for ensuring uniform application. Black colour shall never be used for curing in very hot weather. In order to prevent glare, a colouring pigment may be added to white compounds.

Black curing compounds are either Bituminous or Asphaltic emulsions and shall be used to surfaces which are to be covered by back filling or on the floor which is to be covered with tiles and linoleum.

White curing compound shall be used for the surfaces of tall structures under exposure of hot sun where other method of curing cannot be properly ensured.

d) Curing by Chemical Coating

For chemical curing, sodium silicate or calcium chloride is used. The use of calcium chloride shall be done with the approval of the Engineer. Normally, the sodium silicate mixed with water is applied over concrete surface and, when it dries up, it forms a thin varnish like film, which fills up the pores, and surface voids and prevents evaporation of water. This also acts like curing compound but only difference is that curing compounds are available in ready mixed emulsion forms while sodium silicate is to be mixed with water at site.

3.30.3 Limitation to Use of Different Methods of Curing:

i) Curing by the processes as indicated in Section B – Clause 3-24 and more specifically as per sub-clause 2(b) of the above clause gives very good results in normal warm climate for maturity of concrete.

ii) In cold weather, the process as indicated in sub-clause 2(b) of clause 3-24 gives very good result for maturity of concrete.

iii) Where water cement ratio is less than 0.5, the methods indicated in sub-clause 2(d) and 2(e) of clause 3-24 of Section B, shall not be used.

3.31 Testing of Concrete

3.31.1 General

The Contractor shall carry out, entirely at his own cost, all sampling and testing in accordance with the relevant IS standards and as supplemented herein. The Contractor shall get all tests done in an approved laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

3.31.2 Consistency Test (Tests of Fresh Concrete)

At the place of deposition/pouring of the concrete, to control the consistency slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with IS 1199 as directed by the Engineer.

The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor and the Engineer. That register shall be considered as the property of ..., and shall be kept by the Contractor at site in safe custody.

The results of the slump tests/compacting factor tests shall tally, within accepted variation of 12%, with the results in the respective design mix, in case of mix design concrete and with the values indicated in the table under clause 6.1 of IS:456 in case of nominal mix concrete.

For any particular batch of concrete, if the results do not conform to the requirements as specified in IS 456, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost ....

3.31.3 Strength Test of Concrete
While placing concrete, the Contractor shall make six (6) 150 mm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be either according to clause 14.2 of IS:456 or as directed by the Engineer.

The cubes shall be prepared, cured and tested according to IS 516. Out of the six (6) test cubes, 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting. A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer. That register shall be considered as the property of the Contractor.

- a) Reference to the specific structural member
- b) Mark on cubes
- c) The grade of concrete
- d) The mix of concrete
- e) Date and time
- f) Crushing strength at 7 days
- g) Crushing strength at 28 days
- h) Any other information directed by the Engineer.

### 3.31.4 Acceptance Criteria for Test Cubes

The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under clause 15 of IS: 456.

### 3.31.5 Non-destructive Tests on Hardened Concrete

If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under clause 15 of IS:456, non-destructive tests on hardened concrete like core tests and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his own cost.

The core tests and load tests shall comply with the requirements of clause 16.6 of IS: 456 shall be applicable.

### 3.31.7 Concrete below Specified Strength

In case of failure of test cubes to meet the specified requirements, the Engineer may take one of the following actions:

1. Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at the Contractor's expense.
2. Instruct the Contractor to carry out additional tests and/or works to ensure the soundness of the structure at the Contractor's expense.
3. Accept the work with reduction in the rate in appropriate item.

### 3.31.8 Concrete failed in Non-destruction Tests

In case test results of the core tests or load tests in a particular work do not comply with requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS 456, the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer no extra cost, and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant form work, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

### 3.32 EXPANSION JOINTS

#### 3.32.1 GENERAL
Expansion joints shall be provided where shown on the drawings or as directed. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings.

The contractor shall ensure that no debris is allowed to enter expansion joints.

Expansion joints shall be provided as per drawings.

Contractor shall ensure that expansion joints are made water-tight and that no leakage occurs through these joints for which he shall be responsible to redo at his own cost.

3.32.2 OPEN JOINT FILLERS

Where shown on the drawings, open joints in the structure shall be filled with joint fillers.

The joint filler shall be easily and uniformly compressible to its original thickness, tamp able, easily cut or sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water and free of any constituent which will bleed into or stain the concrete.

The joint filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling and placing to permit the formation of straight joints.

3.32.3 JOINT SEALING COMPOUNDS

Joints sealing compounds shall seal joints in concrete against the passage of water prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete shall have good extensibility and adhesion to concrete surfaces and shall have resistant to flow and weathering. Polysulphide joints where specified on the drawings shall be seated with polysulphide liquid polymer, stored, mixed handled, applied and cured strictly in dimensions, thoroughly cleaned and treated with recommended primer strictly in accordance with the manufacturer’s written instructions prior to sealing. The Contractor shall use only competent personnel experienced in the application of polysulphide for such work.

Where specified in the drawings, rubber/bituminous based sealant shall be of an approved manufacturer.

The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer’s written instructions.

3.32.4 WATER BARS

Where water bars are shown on the drawings, the joints shall incorporate an approved PVC external type water-bar complete with all necessary molded or prefabricated intersection pieces assembled in accordance with the drawings with bends and butt joints in running lengths made by heat welding in an electrically heated jig.

Jointing and fixing of water-bars shall be carried out strictly in accordance with the manufacturers written instructions.

The water-bars shall be installed so that they are securely held in their correct position during the placing and compacting of the concrete.

Where reinforcement is presented adjacent to water-bars, adequate clearance shall be left between the reinforcement and water-beds to facilitate of the concrete.

3.33 CRACKS

If any cracks develop in the reinforced cement concrete construction which may be detrimental to the strength of the construction, the contractor at his own expense shall test the structural element in question. If under these test loads the cracks shall develop further the contractor at his own expense shall dismantle the construction, cart away the debris, replace the construction and carry out all consequential work there to at no extra cost.
If the cracks are not detrimental to the stability of the construction, the contractor at his own expense shall grout the cracks with pneumatically applied mortar. At his own expense and risk he shall also make good all other building works such as plaster, molding, surface finish of floods, roofs, Ceiling etc. which have suffered damage either in appearance or stability owing to such cracks.

The repair work shall be carried out to the satisfaction of the Engineer-in-charge. The decision of the Engineer-in-charge as to the extent of the liability of the contractor in the above matter shall be final and binding on the contractor.

3.34 SUPERVISION

All concreting work shall be done under strict supervision of the qualified and experienced representatives of the Contractor. The contractor’s Engineer and supervisor who are in charge of concreting work shall be skilled in this class of work and shall personally supervise all the concreting operations.

Special attention shall be paid to the following:-

(a) Proportioning, mixing and quality testing of the materials with particular control on the water cement ratio.
(b) Laying of material in place and thorough compaction of the concrete to ensure solidity and freedom from voids and honey combing.
(c) Proper curing for the requisite period.
(d) Reinforcement and inserts/embodiments position are not disturbed during concreting and consolidation by vibration.

3.35 QUALITY CONTROL

The Engineer-in-charge reserves the right to make changes in the mix proportions including the increased cement content or/and a change in the Contractor’s control procedure, should the quality control during progress of the works prove to be inadequate in his opinion.

All the concrete work shall be true to level, plumb and square within the acceptable tolerance. The corners, edges and rises in all cases shall be unbroken and finished properly and carefully.

3.36 TOLERANCES

The acceptable tolerances for formed concrete surfaces shall be given below: -

a) Variation from plumb for -
   i. Columns and walls to be rendered 6 mm in 3 meters
   ii. Exposed columns and walls 3 mm in 3 meters
b) Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls: - 6 mm & + 12mm

All the works executed beyond the tolerance limits are liable to be rejected and no extra cost shall be paid to the contractor for reconstructing the same as desired by Engineer-in-charge.

3.37 TESTING ROOM

A testing room of not less than 10 sqm equipped with the following apparatus and qualified concrete technician, labour and materials required for carrying out tests therein shall be provided by the contractor at his own cost:

1. Sieve Set (For aggregate 20 mm down)
   40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, 600 micron, 300 micron, and 75 micron having diameter of 45 cms.

2. Weighing
   a) Physical balance cap. 200 gms with weigh box (accuracy 0.5 gm)
b) Counter Scale cap 20 Kg

c) Weights

<table>
<thead>
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<th>Item</th>
<th>Description</th>
<th>Quantity</th>
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<tr>
<td></td>
<td>5 kg</td>
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<tr>
<td></td>
<td>2kg</td>
<td>2 Nos</td>
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<tr>
<td></td>
<td>1 kg</td>
<td>1 No.</td>
</tr>
<tr>
<td></td>
<td>500 gms</td>
<td>1 No.</td>
</tr>
<tr>
<td></td>
<td>200 gms</td>
<td>1 No.</td>
</tr>
<tr>
<td></td>
<td>100 gms</td>
<td>1 No.</td>
</tr>
</tbody>
</table>

3. Slump Cones  2 Nos
4. 15 cms moulds  18 no.
5. Electric/Kerosene Heater
6. pans etc. as directed
7. Measuring Cylinders of 1000 ml., 500 ml and 100ml.
8. Wash bottles of the Capacity of 500 ml., 2 Nos.
9. Sink
10. Work benches, shelves, desks and any other furniture and lighting as required
11. Spring balance dial type cap. 100 kg

12. Litre measures
   a) 10 Lit 1 No.
   b) 5 Lit 1 No.
   c) 2 Lit 2 Nos
   d) 1 Lit 1 No.
   e) 1/2 Lit 1 No.
14. Oven.

3.38 CO-ORDINATION OF WORK

The contractor is fully responsible for coordinating with the other agencies for sanitary, electrical work, etc. to ensure execution of their work related to commencement of concreting. Nothing extra shall be payable to the contractor, if the works pertaining to concreting have to be dismantled and redone due to lack of co-ordination on the part of the contractor in ensuring completion of works of such agencies before concreting had been undertaken.

4 SPECIFICATIONS FOR STEEL REINFORCEMENT

4.1 GENERAL

4.1.1 DESCRIPTION

This section covers the requirements for fabricating, delivering and placing of steel reinforcement in position for casting all types of concrete work.

4.1.2 RELATED WORK SPECIFIED ELSEWHERE

Applicable Codes and Standards:

The codes and standards generally applicable to the work this section is listed in this section.

IS: 280 Mild wire for general engineering purpose
IS: 432 Part I Mild steel and medium tensile steel bars
Part II Hard drawn steel wire
IS: 456 Code of practice for plain and reinforced concrete
IS: 1139 Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement
IS: 1566 Hard drawn steel wire fabric for concrete reinforcement
IS: 2502 Code of Practice for bending and fixing of bars for concrete reinforcement
The following clauses are intended to amplify the requirements of the reference documents listed above and the contractor/Engineer-in-charge shall comply with these clauses.

4.2 SUBMITALS

4.2.1. BAR BENDING SCHEDULE

The Contractor shall prepare Bar Bending Schedule for reinforcement before fabrication

4.3 MATERIALS

4.3.1 STEEL REINFORCEMENT

Steel reinforcement to be procured by the Contractor for works shall be either of the following types:-
(a) Mild steel of Grade 1 tested quality conforming to IS: 432-Part
(b) 3370 Code of practice for concrete structures for (Part 1 to IV) the storage of liquids
(c) High yield strength cold worked deformed steel bars of tested quality conforming to IS: 1786 or hot rolled high tensile deformed steel bars of tested quality conforming to IS: 1139.
(d) Hard drawn steel fabric conforming to IS: 1566.
(e) Where galvanized reinforcement is specified in the drawings, the bars or mesh shall be hot-dip galvanized after bending generally in accordance with IS: 2629 and IS: 4759. Galvanized reinforcement shall be coated with a layer of zinc nowhere less than 0.05 mm in thickness.

All reinforcement shall be stored horizontally above ground level on supports, skids or other approved supports, clear of any running or standing water. Contact with soil should be avoided. Proper drainage and protection from the elements shall be provided to minimize corrosion.

Before steel reinforcement is placed in position, the surface of the reinforcement shall be cleaned of rust, dust, grease and other objectionable substances. In order to confirm them self the quality periodical tests as specified as the relevant IS shall be conducted by the contractor at his own cost for the materials procured by the Contractor.

4.3.2. BINDING WIRE

Binding wire shall be black annealed steel wire conforming to IS: 280 and of minimum 18 gauges.

4.3.3. WELDING ELECTRODES

Electrodes used for welding of steel bars shall be of ordinary mild steel grade electrodes conforming to IS: 814 and shall be of the best quality approved.

4.4 STORAGE

Reinforcement steel shall be handled and stored in a manner that bending or distortion of the bars is avoided and contamination of steel is prevented

All reinforcement shall be stored horizontally above ground level on supports, skids or other approved supports, clear of any running or standing water. Contact with soil should be avoided. Proper drainage and protection from the elements shall be provided to minimize corrosion.

Bars of different classifications and diameters shall be stored separately. A record shall be kept of the batch numbers of reinforcement deliveries in such a form that the part of the works in which particular reinforcement is used can be readily identified.

Welding electrodes shall be. Stored in moisture control-led environment in accordance with the Manufacturer’s recommendations.

4.5 FABRICATION
Reinforcement steel shall be carefully and accurately cut, bent or formed to the dimensions and configurations shown on the drawings and as per bar bending schedules approved / Engineer-in-charge. All reinforcement shall be bent cold using appropriate pin size. Bars may be preheated only on approval. Quenching shall not cool hot bars. Bends shall be in accordance with IS: 2502.

It shall be ensured that the bars are not straightened in any manner that will injure the material. Any bars incorrectly bent shall be used only if means for straightening and re-binding be such as not to affect adversely the material. Reinforcement shall not be re-bent or straightened without prior review. No reinforcement shall be placed in position on the works without approval, whether or not it is partially embedded in hardened concrete.

Reinforcement steel having a reduced section, visible transverse cracks in bends, or otherwise damaged in anyway shall not be used. Spiral reinforcement shall be accurately fabricated to the diameter and pitch shown on the drawings. One and one half finishing turns shall be provided at both top and bottom unless shown otherwise.

Cut ends of galvanized rods shall be given a protective coat of an approved zinc paint immediately after cutting.

4.6 LAPPING

As far as possible bars of maximum length available shall be used. All bars shall be in one length unless otherwise shown on the drawings or agreed with the Engineer-in-charge.

Laps shown on the drawings or otherwise specified shall be based on the used of bars of maximum length by the contractor. In case the Contractor wishes to use shorter bars, laps shall be provided at the Contractor’s cost in the manner and locations approved / Engineer-in-charge.

Not more than 1/3 rd of the bars or as specified in the drawings shall be lapped at one section.

Reinforcement bars shall not be welded unless shown on the drawings or instructed / Engineer-in-charge.

4.7 PLACEMENT

All reinforcement shall be placed accurately and maintained in the position indicated on the drawings.

The contractor shall provide approved type of supports for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as called for in drawings. Pre-cast cement concrete blocks of required shapes and size, MS. chairs and spacers bars shall be used in order to ensure accurate positioning of reinforcement. Pre-cast concrete blocks shall be cast well in advance and shall be at least equal in quality to the class of concrete specified in the work.

In fair faces of concrete, temporary spacers only shall be used and removed or withdrawn as compaction of concrete proceeds. Spacers will not be permitted to be left in fair faces of concrete.

All intersections of the reinforcements shall be securely tied with two strands of binds wire twisted tight to make the skeleton or net work rigid so that the reinforcement is not displaced during placing of concrete.

Tack welding of crossing bars shall not be done except as authorized or directed / Engineer-in-charge. Nothing extra will be paid for tack welding.

The contractor shall take all responsible precautions to ensure that when handling or erecting reinforcement no damage shall be done to finished concrete Bars that are partially embedded in concrete shall not be filed bent partially embedded in concrete shall not be field bent unless concurrence has been obtained from the Engineer-in-charge.

Walkways and borrow runs for placing and compacting the concrete shall be independent of the reinforcement. Loose binding wire and other extraneous metal shall be removed from inside the form work prior to concrete placing.
Without relieving the Contractor of the responsibilities for the correctness thereof, the reinforcement shall be inspected and approved in writing before any concrete is placed and the contractor shall allow sufficient time for such inspecting and any subsequent remedial action to be carried out.

No part of the reinforcement shall be used for conducting electrical currents.

4.8 COVER TO REINFORCEMENT

Unless shown otherwise on the drawings, minimum cover for all reinforcement shall be provided as per IS: 456 cares shall be taken to maintain the correct cover to reinforcement.

For concrete members exposed to weather, earth, action of harmful chemicals, acid vapor, saline atmosphere, sulphurous smoke etc minimum cover for reinforcement shall be increased by 15 cm to 40 mm as directed /Engineer-in-charge.

The maximum cover for reinforcement shall not be greater than that specified above or shown on the drawings plus 10 mm except for bundled bars.

For bundled bars, minimum, concrete cover shall be equal to the equivalent diameter of the bundle but need not be greater than 50 mm.

Exposed reinforcement intended for binding with future extensions shall be protected from corrosion as shown in the drawings.

4.9 CLEANING

After placing, the reinforcement shall be maintained in a clean condition until the concrete is placed. On no account the bars shall be oiled or painted or mould oil used on the formwork be allowed to come in contact with the bars.

Before concreting is commenced, the bars shall be thoroughly cleaned with dry gunny bags if they are coated lightly with rust or other impurities.

4.10 WORK WILL INCLUDE

a) All cutting to lengths, labour in bending and cranking, forming hook ends, handling, hoisting and all that is necessary to fix reinforcement in work as per Drawings and specifications This shall also include all that is fairly intended and is necessary for completion of work.

b) Cost of pre-cast concrete cover blocks to maintain cover and holding reinforcement in position, chairs, spaces, dowels, pins, laps, etc.

c) For fabricating and fixing reinforcement in any structural member irrespective of its location, dimension and level.

d) Work at all levels.

e) All the above mentioned works shall be included in the quoted rates Nothing extra shall be payable to the contractor on this account

f) Reinforcement Steel procurement shall be done by the Contractor.

5 SPECIFICATIONS FOR FORMWORK

5.1 GENERAL

5.1.1 DESCRIPTION

This section covers the requirements for providing, fabricating and erecting of form work including propping, bracing, shoring, strutting, rising, bolting, wedging and all other temporary and all other temporary supports to the concrete during the process of setting subsequent removal of forms.
5.1.2 RELATED WORK SPECIFIED ELSEWHERE

a) Cast-in-place Reinforced Concrete

5.1.3 APPLICABLE CODES AND STANDARDS

The codes and standards generally applicable to the work of this section are listed hereinafter

IS: 4990 Plywood for concrete shuttering work.

5.2 SUBMITTALS

5.2.1 TYPE OF FORM WORK

Prior to start of delivery of material for formwork, the contractor shall prepare samples of different types of formwork for about 10sqm and obtain approval.

5.2.2 DESIGN OF FORMS

Before fabricating of forms, the contractor shall submit design calculations for proposed formwork to Engineer-in-charge for his approval. However, the approval of his responsibility for adequately constructing and maintaining the forms so that they will function properly.

5.2.3 TIE BOLTS

In case the contractor proposes to use tie bolts running through the concrete, the location and size of such tie bolts shall be submitted to Engineer-in-charge for his Approval.

5.3 MATERIALS

5.3.1 Formwork shall be timber, plywood, steel or any other material capable of resisting damage to the contact faces under normal conditions of erecting forms, fixing steel and placing concrete. The selection of materials suitable for formwork shall be made by the Contractor based on the maximum quality consistent with the specified finished and safety.

5.3.2 TIMBER

Timber used for formwork shall be easily workable with nails without splitting. It shall be stable and into liable to warp when exposed to sun and rain or wetted during concreting.

5.3.3 PLYWOOD

Plywood used for formwork shall be 12 mm thick shuttering quality plywood complying with IS: 4990 and of make approved.

5.3.4 STEEL

Steel formwork shall be made of minimum 2 mm thick or more as required black sheets stiffened with angle iron frame made out of M S angles 40 mm X 6 mm.

5.4 DESIGN CRITERIA

Formwork shall be designed for the loads and lateral pressures due to dead weight of concrete, superimposed live loads of workmen, materials and plants and for other loads as indicated on the drawings. Forms shall be
designed to have sufficient strength to carry on the hydrostatic head of concrete as a liquid without deflection tolerances exceeding the acceptable limits.

Where necessary to maintain the tolerances indicated on the drawings. The formwork shall be cambered to compensate for anticipated deflections due to the weight and pressure of the fresh concrete, and also due to any other construction loads. Unless otherwise shown or specified, the camber shall be provided as below:-

<table>
<thead>
<tr>
<th>Types of member</th>
<th>Compression Steel As % of tensile steel</th>
<th>Camber Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple span</td>
<td>0%</td>
<td>0.066</td>
</tr>
<tr>
<td>Continuous Restrained</td>
<td>50%</td>
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<td>span Cantilever</td>
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</tbody>
</table>

Camber in cms Where \( \frac{K \times L \times 2.54}{D} \)

\( K = \) Camber coefficient
\( L = \) Length of member in meter
\( D = \) Depth of member in meter

5.5 ERECTION OF FORMWORK

Forms shall be used wherever necessary to confine the concrete during vibration and to shape it to the required line. The formwork shall conform to shapes, lines, levels and dimensions of the concrete sections shown on the drawings.

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete and shall be maintained rigidly in position. Form work shall be adequately supported by adequate number and size of struts, braces, ties and props to ensure rigidity of forms during concreting. Where props rest on natural or filled up ground, to avoid any settlement, the soil shall be thoroughly compacted and bases of props shall be sufficient size so as to restrict the bearing on the ground to 50 t/ sqm

Forms shall be tight enough to prevent loss of mortar from the concrete and to produce dense, homogenous and uniformly coloured concrete completely free from honeycombing or surface roughness. Joints in formwork shall be designed to prevent leakage, not only between individual elements forming the panels but also from the horizontal and vertical junction between the panels themselves.

If form work is held together by bolts or wires, those shall be so fixed that no reinforcement bar is exposed on surface against which concrete is to be laid.

Hole left in the concrete by these tie-bolts shall be filled as specified by him at the Contractor’s expense.

Wedges, clamps and bolts shall be used wherever practicable instead of nails.

All formwork erected shall be approved /Engineer-in-charge before concreting is started.

5.6 CLEANING AND OILING OF FORMS

At the time concrete is placed in the forms, the surface of the forms in contact with the concrete shall be free from encrustations of mortar, grout or other foreign materials. Temporary openings shall be left at the bottom of formwork to enable, sawdust, shavings, wire cuttings and other foreign material to be worked out form the interior of the forms before the concrete is placed.
The surface of the forms to be in contact with the concrete shall be coated with an approved coating that will effectively prevent sticking and will not stain the concrete surfaces. After each use the surfaces of forms in contact with concrete shall be cleaned, well settled and treated with form oil approved by Engineer-in-charge. Lubricating (machine) oils shall not be used.

Oiling shall be done before reinforcement has been placed and care shall be taken that no oil comes in contact with the reinforcement while it is being placed in positions.

Immediately before concreting is commenced the formworks shall be carefully examined to see that all dirt, shavings, sawdust and other refuse have been removed and the formwork shall be wetted thoroughly to prevent absorption of water from concrete. The formwork shall be kept wet during concreting and for the whole time that it is left in place.

5.7 REMOVAL OF FORM WORK

Form works shall be removed carefully so as to prevent damage too the concrete. Wooden wedge only shall be used between the concrete surface and the form where force is necessary to separate the form from the concrete. Metal wedge, bars or tools shall not be used for this purpose. Any concrete damaged in the process of removing the forms shall be repaired in accordance with the provision of concrete specifications.

Unless otherwise permitted , the forms shall not be stripped in less than the minimum periods specified in IS: 456. Above period can be increased if necessary for structural stability.

All non-supporting forms shall be loosened and removed during regular working hours, and as soon as the concrete has hardened sufficiently to prevent damage from the removal of the forms. All false work and forms supporting concrete beam and slabs, or other members subject to direct bending stress, shall not be removed or released until the concrete has attained sufficient strength to ensure structural stability and to carry both the dead and live loads including any construction loads which may be placed upon it.

No construction loads exceeding the combination of superimposed dead load plus specified live load shall be supported on any unshared portion of the structure under construction, unless analysis indicates adequate strength to support such additional loads.

Form work shall be removed in such a manner so as not to impair safety and serviceability of the structure. It shall be removed gradually to prevent sudden application of loads to the concrete. All concrete to be exposed shall have sufficient strength to prevent any damage caused by removal of formwork.

5.7.1. HACKING:

Immediately after removal of forms, the concrete surface intended to be either plastered or finished, shall be roughened with brush hammer or with chisel and hammer as directed by the construction manager to make the surface sufficiently coarse and rough to provide a bonding key for plaster.

No extra payments shall be made to the Contractor for such work on concrete surface after removal of the form work.

No payment shall be made for temporary formwork used in concreting, or for form work required for joints or bulk-heads, in floor or elsewhere, whether such joints are to be covered later with concrete or mastic or other materials.

5.7.2. POCKETS AND OPENINGS:

Where boxes, pockets or openings are required (not exceeding 0.1 sqm) to be formed in the concrete. No deduction shall be made for the area of box or pockets in measuring the area of concrete surface shuttered. In other words the area of shuttering shall be reckoned as if box of pocket or openings were not present.
However, on measuring the concrete quantity, the volume of the box or pocket shall be deducted. If the area of box or pocket or openings against the shuttered faces exceeds 0.1 sqm. It shall be paid not as a box or pocket or opening but as formwork at the rates for formwork.

No extra payment shall be made for holes to be made in the form work for inserting electrical conduits hooks for fans etc.

5.8 REUSE OF FORMS
Immediately after the forms are removed, they shall be cleaned with jet of water and a soft brush before they are reused.

The contractor shall not be permitted reuse of any forms which has worn out and has become unfit for formwork. The Engineer-in-charge may in his absolute discretion, order rejection of any forms he considers unfit for use in the works, and order their removal from the site.

6 SPECIFICATIONS FOR BRICK MASONRY WORK:-

6.1 SCOPE:-

The Contractor shall provide all labour, materials, scaffolding operations, equipment and incidentals necessary required for the completion of all brickwork called for in the drawings and documents and that which is fairly intended for smooth completion of the work.

6.1.1 BRICKS (1st CLASS):-

The bricks shall be well burnt locally available from good brick earth and shall be of uniform size (9” x 4.5” x 3”) unless otherwise specified They shall be of uniform deep red, cherry or copper colour, thoroughly well burnt without being verified and regular in shapes.

6.1.2 MORTARS:-

All brick work shall laid with specified mortar of good workable consistency.

6.1.3 SOAKING OF BRICKS:-

All bricks required for masonry in cement or composite lime mortars shall be thoroughly soaked in clean water for at least one hour in advance of sufficient size immediately before use. The cessation of bubbles when the bricks are immersed in water is an indication of thorough soaking of bricks.

6.1.4 LAYING:-

a) Bricks shall be laid in English bond, unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond. Closers in such cases shall be cut to the required size and used near the ends of the walls.

b) The walls shall be taken up truly plumb. All courses shall be laid truly horizontal and all vertical joints join shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. The thickness of brick courses shall be kept uniform and for this purpose straight edge with graduations

Showing the thickness of each brick course including joint shall be used. Bricks shall be laid with frogs upwards.

c) The walls of a structure shall be carried up regularly and nearly at one level and no portion of the work shall be left more than 3 ft. below the rest of the work. Where this is not possible the work shall be raked back according to bond (and not left toothed) at an angle not exceeding 45°.
d) All iron fixtures pipes, outlets of water, holdfasts of doors and windows, etc., which are required to be built in walls, shall be embedded in cement mortar or in cement concrete as specified, in their correct positions as the work proceeds. Nothing extra shall be paid for such extra cement mortar or of the nature stated above.

6.1.5. JOINTS:-

Bricks shall be so laid that all joints are quite full of mortar. The thickness of the bed joints shall in no case exceed 3/8”, unless otherwise specified. The face of joints shall be raked to a minimum depth of 0.5” by raking tool daily during the progress of work when the mortar is still green, so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. The face of brick work shall be cleaned daily and all mortar droppings removed.

6.1.6. BRICK-IN-EDGE COPING

The top course of all plinths, parapets, steps and tops of walls below R.C.C. slabs or beams shall be laid with brick on edge, unless otherwise specified Proper care shall be taken that the bricks forming the top corners and ends of walls shall be properly radiate and keyed in to position.

6.1.7. CURING:-

Green Work shall be protected from rain by suitable covering Brick Masonry with cement or composite mortar shall be kept constantly moist on all faces for a minimum period of 7 (Seven) days. In case of fat lime mortar, curing shall commence two days after the laying of masonry and shall continue for 7 (seven) days.

6.1.8. SCAFFOLDING:

Double scaffolding having two sets of vertical supports shall be provided The supports shall be sound and strong Tied together with horizontal pieces over which the scaffolding planks shall be fixed. In building up to two stories, single scaffolding shall be allowed In this case, the inner end of the horizontal scaffolding pole shall rest in a hole provided in the header course only. Only one header or each pole shall be left out. The holds left in masonry work for supporting the scaffoldings shall be filled and made good, before plastering. The Contractor shall be responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads likely to come upon it.

6.2. HALF BRICK AND THREE INCH THICK MASONRY:-

6.2.1. The work shall be done exactly similar to the specification ‘BRICK WORK’ except that all courses shall be laid with stretchers.

6.2.2. Cement Mortar 1:4 (1 cement: 4 sand) shall be used unless otherwise specified in the description of the item.

6.2.3. The description of the item shall mention whether or not, reinforcement is to be provided, when the brick work is to be reinforced, hoop iron band 1” x 1/16” (2.5 c.m. x 1.6. mm) shall be embedded in the cement mortar at every fourth course or as described in the description of the item. The hoop iron shall be hooked (given a double lap) with minimum of 9” hooks at all angles and junctions. At either end of the wall, 2” (5 c.m.) lengths of the hoops shall be bent up or down so as to take a firm grip of the brick work. When hoop iron is not available equivalent reinforcement in the form of mild steel can be used after approval.

6.3. RUBBLE MASONRY:-

6.3.1. MATERIAL:-
The stones to be used for the masonry shall be hard, sound, free from cracks, flaws etc., and shall be from approved Quarries. They shall generally be freshly quarried with sharp edges and worn clean face. They shall be free from rounded, or weathered surfaces or skin or costing which prevents the adherence of mortar. Size & shape of stone shall be as per the requirement.

The stones to be used as headers, quoins, copings etc., shall comply with the requirements of facing and hearted as may be relevant and shall further comply with the facing stones shall be selected from the mass of quarry stones for their greater size, goods beds, close grain and uniform colour. The beds and joints shall have an average bearing of not less than 2 cm. The quoins shall be of selected stone and shall normally be 10 cm. x 24 cm. x 39 cm. or as directed by Engineer-m-charge. The faces of quoins shall be rough tooled with 40 mm. chisel drafts at the corner edges. The beds and tops shall be dressed square to the face and rough tooled to 10 cm from the face and vertical joints similarly dressed to 4 cm. from the face. In the embedded portion the length of side shall not be less than that of exposed side opposite by more than 8 cm for the longer side and 60 cm for the shorter side.

One through stone shall be provided per half sq m. of facing evenly distributed in a staggered pattern. They shall be about 0.03 sq m in face area and shall have a tailing of the full width of the masonry. If the wall or masonry be over 60 cm. thick a line of headers overlapping each other be at least 15 cm. shall be laid right through wall a face to back. The length of the interior headers shall not be less than 45 cm & their average cross section area shall not be less than 0.025 sqm. Face header shall be distinctly marked on its face.

6.3.2 MORTAR:-

Unless otherwise mentioned the mortar for masonry work shall be composed of 1 part of cement and 5 parts of coarse approved sand the sand for mortar shall be as per I S, 2116-1965

6.3.3 SCAFFOLDING:-

It shall be single or double as is warranted for the particular work. Put log holes shall be made good by bricks to match the face work when put logs are removed after ensuring that the holes behind are solidly filled with 1:4:8 cement concretes.

6.3.4 CONSTRUCTION:-

The masonry shall be laid to lines, levels, curve and shape as shown on the drawings, fixtures, plugs, brames, pipes conducts etc., if any shall be built in at places when on the plans which laying the masonry and not later by removing the stones already laid.

i. Stones in the hearting shall be laid on their broadest face which gives better opportunity to fill the space between tone

ii. Stratified stones must be laid on their natural beds. All bed joints shall be normal to the pressure upon them.

iii. In battered walls, the beds of stone & the plane of course should be at right angles to the better.

iv. If masonry is to be laid directly on excavated bed or concrete footing, the bed shall be cleared or all loose materials cleaned and wetted just before laying masonry. Bushings shall not project more than 40 mm, in faces where joints are to be pointed or struck and 12 mm. in faces proposed to be plastered. Quoins in the unexposed portions shall have the same facing as the rubble stones and shall have uniform chisel drafts of 40 mm. in the exposed portions and up to 15 cm. below the finished ground level, quoins shall be rough tooled with 40 mm. chisel drafts at the corner edges.

v. The face stones shall be laid without any pinning on the exposed faces. In each course the headers or lines of headers as the case may be, shall kept in position as specified intervals and with specified laps where such laps are required before the masonry of the layer is commenced to ensure that they are being laid properly and intervals. They shall be embedded as masonry in that layer progress. Quoins
shall be laid stretcher and header wise as seen on each face and shall correspond to the arrangement of quoins in the same course.

vi. The stones shall be wetted before laying in mortar. Each masonry shall be supplied by the contractor with a vessel full of water and tumbler for wetting stones, care being taken not to spill any water on green masonry. The bed which is to receive the stone shall be cleaned, wetted and covered with a layer of fresh mortar. All stone shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a wooden mallet immediately on placement and solidly bedded in mortar before it is. Clean dips and spalls carefully selected to fit in the spaces shall be wedged in to mortar joints and beds wherever necessary to avoid thick beds or joints and beds necessary to avoid thick beds or joints of mortar. When the foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. If a portion of masonry is dismantled, every stone must be found with mortar adhering fast to all its embedded surface and there shall be no hollows. This will be one of the tests in deciding if the masonry is good or bad, if need arises, where hollows or other defects are suspected a stone here or there may be removed for confirmation. If these are confirmed such portions shall be dismantled and rebuilt at the cost of the contractor.

vii. Face work and heating shall be brought up evenly but the top of each course shall not be levelled up by use of flat chips.

viii. No face joints shall exceed 16 mm and the same shall be struck while mortar is fresh.

ix. The face joints should be properly struck while the mortar is fresh. When no pointing or is to be done. But if plastering or pointing is required to be done then joint shall be raked out when mortar is fresh.

x. Stones in corners of walls and angles which are to be plastered shall be rounded. The corners shall also be rounded.

xi. in plaster while plastering. The frames of doors, windows, cupboards, etc., shall be housed in to the masonry while laying the masonry only. Chisel dressing for the width of door and window frame shall be done to obtain good fit between the frame and masonry.

t. Jambs shall be made up of quoins only. Where shown to other than square, the jambs shall be splayed to conform to the drawings or the instructions of Engineer-in-charge and shall be true to the templates. Quoins of the full thickness of the wall shall be provided at the rate of 3 for each side of the door opening and 2 for each side of the window opening when the wall is 40 cm. thick or make up full thickness of the wall with break of joint of not less than 8 cm. with stones above and below.

xiii. Holes of the required size and shape shall be left in the masonry during construction for fixing pipes, service lines, passage of water etc., and extra hollows loft shall be filled with 1:3 cement mortar of 1:3:6 cement concrete and the face shall be finished with matching stones.

xiv. The top of masonry on which coping, R.C.C. slab or other flooring is to be laid shall be finished level or the required slope with stones and mortar to give an even bearing. Bed blocks of stone or R.C.C. shall be built-up in the masonry under the beams.

xv. The rate of raising un-coursed rubble masonry brought up in uniform levels may be limited to a height of 69 cm.

xvi. per day in case of cement mortar and 45 cm. in case of lime mortar.

xvii. All masonry work shall be kept well watered for 14 days after laying.

7. SPECIFICATION FOR DOORS & WINDOWS (WOOD WORK)

7.1 MATERIAL
7.1.1 TIMBER
7.1.1.1 TEAK WOOD
Teakwood shall be second class Indian Teakwood conforming to IS: 4021 of good quality, well seasoned and free from defects such as cracks, dead knots, sapwood etc. No individual and sound knot shall be more than 15 sq.cm in size and the aggregate area of such knots shall not exceed 2% of the areas of the piece. The timber shall be fairly close grained having not less than 2 growth rings per cm. Width in cross-section.

7.1.1.2 Hard Wood:
Hard wood shall be first class conforming to IS 4021 of good quality, well seasoned and free from defects such as Dead knots, cracks, sapwood etc. No individual hard and sound knot shall exceed 6 sq.cm in size with no dimension more than 50 mm and the aggregate area of such knots shall not be more than 1% of the area of the piece. There shall not be less than 5 growth rings per cm. Width in cross-section.

7.1.1.3 Moisture content in timber
The maximum permissible percentage of moisture content for well seasoned timber shall be as per IS 287.

7.1.1.4 Workmanship of wood work Workmanship for wood and joinery shall be as per IS 1200 and IS 4021.

7.1.1.5 Painting / Polishing of wood work
Painting / polishing of wood work shall be in accordance with clause Nos. of specification No.6.9.2 to 6.11.3.

7.2 WOODEN DOOR / WINDOW FRAME
Wooden door / window frame shall be made of specified wood as per item description and shall be in accordance with detailed drawings.

The wooden members of the frame shall be planed smooth and accurate to the full dimensions. Rebates, rounding, molding etc., shall be done before the members are jointed into frames.

Joints in the frame work shall be perfect with square edges and shall be pinned with hard wood / bamboo pins of 10 to 15 mm dia.

Wood work shall be painted / polished or otherwise treated as specified. All exposed portions shall be coated with wood primer and concealed surface by bituminous paints as per clause No. 6.

Before any surface treatment is applied, the wood work shall be got approved by the Engineer-in-charge. The frames shall be fixed only after acceptance by the Engineer-in-charge. The frames shall be fixed to the masonry by 300 mm x 25 mm x 6mm MS hold fasts embedded in M-15 grade concrete block of 350 mm x 100mm x 100 mm in the hole of the masonry. In case of concrete, frames shall be fixed by 96mm long 12 mm dia metallic dash fasteners.

7.3 SHUTTERS:

7.3.1. Particle Board flush shutter:
Particle board flush shutter shall in general conform to IS: 2202

7.3.1.1 Materials

7.3.1.1.1 Particle Board
Particle board shall conform to IS 3097 and shall be three layer flat pressed teak wood based and of exterior grade (Grade –1), type – 1, BWP type, bonded with phenol Formaldehyde synthetic resin conforming to IS: 848.

7.3.1.1.2 Veneers
Veneers shall conform to class – 1 of IS 303 and (BS 476 Part – 7)

7.3.1.1.3 Teak wood
Specification of Teak wood shall same as specified in clause 9.1.1.1
7.3.1.1.4 Hinges

Hinges shall be of brass and butt type conforming to IS: 205. Size of hinges shall be in accordance with shutter width and as per IS: 205.

7.3.1.2 Workmanship

The particle board of required size and thickness shall be lipped on all the edges with T-type, teak wood lipping. The overall board lapping composition shall be uniform and specified thickness and shall be properly sized in view of the operation of shutter.

All the four edges of the door shutter shall be square. The shutter shall be free from twist or warp in its plane. In case of double leaf shutters, the meeting of the stiles shall be rebated by one third the thickness of shutter. The rebating shall be splayed.

The shutter then shall be veneered on both faces by gluing approved shade and textured commercial type 0.5 mm thick veneering conforming to class 1 of IS 303.

The veneering shall be done by gluing the veneer with BWP type, phenol formaldehyde synthetic resin conforming to IS 848 by not press process on the shutter. Workmanship and finish of the veneering shall conform to IS 303.

The shutter shall be fixed to the door frame, by means of hinges @ minimum 3 hinges per leaf, maximum spacing of hinges being 600 mm or as per drawing with suitable sized screws.

The shutter when fitted to the frame shall satisfy all operational aspects of the door like smooth movement, proper closing against the door frame etc.

7.3.2 Glazed Wooden Door shutter

7.3.2.1 Materials

7.3.2.1.1 Wood

Teakwood for various members like stiles, rails etc., shall be as specified in clause No.9.1.1.1.

7.3.2.1.2 Glazing

Glass sheets for glazing shall be

i. 4 mm thick plain glass (wt. 7.2 kg/m²) conforming IS : 2835, or
ii. 5.5 mm thick wired glass conforming to IS: 5437 or
iii. 6.3 mm thick laminated glass conforming to IS: 2553 as case may be as per item description or
iv. 5.5 mm thick toughened glass.

Glass sheets shall be free from flaws, scratches, cracks, bubbles etc.

7.3.2.1.3 Workmanship

Teakwood stiles and rails of size as specified in item description shall be cut accurately and planned smoothly to required dimensions as per drawings. The stiles and rails shall be provided with rebates for fixing the glazing and shall be joined together to form the profile of the shutter as per drawings. The joinery work shall be as approved by Engineer-in-charge. Only after such approval, the joints shall be coated with white lead, pressed and secured by hardwood pins of about 6 mm dia. All the four edges of the shutter shall be square. In case of double leaf doors, rebates shall be provided at the meeting of stiles. Rebates shall be splayed type and one third the thickness of the stiles.
The glass sheets for glazing shall be fixed by teak wood beading having mitered joints as per drawings and shall be fixed by means of approved neoprene based adhesive and nailing, the spacing between the nails being no more than 300 mm.

All wooden surfaces shall be coated with 2 coats of approved make polyurethane with Steiner mixed to achieve desired shade.

The shutter shall be fixed to the door frame, by means of hinge @ minimum 3 hinges per leaf, maximum spacing of hinges being 600 mm or as per drawing with suitable sized screws.

The shutter when fitted to the frame shall satisfy all operational aspects of the door like smooth movement, proper closing against the door frame etc.

7.4 Aluminum Glazed Doors / Windows / Ventilators

7.4.1 General
Aluminum glazed doors / windows / ventilators shall be of specified sectional size, dimension and profile as per drawings.

7.4.2 Materials
All Aluminum sections shall be extruded sections of aluminum alloy as per IS:733 and IS:1285.
Aluminum sections shall be anodized as per IS: 7088 to min, 25 microns.
Glass used for glazing shall be of following type in accordance with item description.
   i. 5.5 mm thick wired glass conforming to IS 5437.
   ii. 6.3 mm thick laminated safety glass conforming to IS 2553.
   iii. 5.5 mm thick transparent sheet glass conforming to IS: 2853 (Wt. 7.2 kg/sqm).

7.4.3 Workmanship
Frames shall be square and flat, the corner of the frame being fabricated to true right angles. Details of construction of frames, shutters etc., shall be as per drawings.

Side hung window shutters shall either be fixed to the frame with pivots, or aluminum alloy hinges. For fixing the hinges, slots shall be cut in the fixed frames and the hinges inserted inside may be riveted to the frame. The hinges shall normally be of the projecting type conforming to IS designation A-5-M of IS – 617, IS 733. In which case peg stay of 300 mm long complete with locking bracket and conforming to IS codes same as for hinges shall be provided. Friction hinges may also be provided in which case peg stays are not required.

The handles for side hung shutters shall be of cast aluminum conforming to IS designation A-5-M of IS 617 and shall be mounted on a handle plate riveted to the opening frames. The handle shall have anodized finish with minimum anodic film thickness of 25 micron of Electro colour finish. The handle shall have a two point nose which shall engage with an aluminum striking plate on the fixed frame. The striking plate shall be finished in the same manner as for the handle.

In case of top hung shutters, aluminum alloy cast hinges and peg stays (same as per side hung shutters) shall be provided.
Center hung shutters shall be hung on the two pairs of cup pivots of aluminum alloy of  IS designation NS – 4 of IS 737 and IS designation A-5-M of IS 617 or chromium / cadmium plated brass / bronze cup pivots riveted to the outer and inner frames to permit to swing through an angle of 850. Cast aluminum (conforming to IS designation A-5-M of IS 617) or chromium / cadmium plated bronze spring catches shall be fitted in the centre of the top bar of the shutter. The spring catch shall be secured to the frame by screwing / riveting to the frame and shall close into and aluminum catch plate riveted / welded to the outside of the outer shutter frame bar.

Aluminum or cadmium plated brass chord pulley wheel in an aluminum bracket shall be fitted at the sill of the shutter with Aluminum or galvanized / cadmium plated steel screws. The door shutters shall be fitted with pivots as specified. The handle for doors shall be of aluminum and as per design. The door shutters shall be provided with locking device, floor spring, O/H door closer and any other hardwares, specified in item.
In case of composite Door / window / ventilator units shall be coupled as per drawing. Weather bar shall be provided whenever a coupling member is fitted over an external opening shutter.

Glazing shall be fixed to the extruded sections by means of extruded aluminum beading. Glass panes shall be provided with rubber lining before fixing. The aluminum frames shall be fixed to the masonry by means of aluminum lugs fixed to the frame (by counter sunk galvanized machine screws) and grouted with M-15 grade concrete in the hole in the masonry as per drawing. In case of concrete wall, the frames shall be fixed by 96 mm long, 12 mm dia metallic dash fasteners. Any steel material coming in contact with aluminum shall be galvanized.

The windows / ventilators / doors shall be checked to ensure smooth operation, perfect level and plumb.

**FIRE DOORS & FITTINGS**

All work is to be carried out in accordance with respective IS Code and specification for Fire Door & fitting as per IS: 3614 (Part I) - 1966

Fully insulated 55 mm thick wooden fire / smoke check door shutter using 31mm thick FR insulation with internal facia of 9mm thick calcium silicate board having density not less than 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 X 4 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 20and 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 thick, 200mm x 300mm / 300mm x 300mm fire rated glass, surrounded with fire proof treated teakwood beading, all around complete in all respects as per manufactures specifications and direction of Engineer in charge.

8. **SPECIFICATION FOR FLOORING & PAVING**

8.1 SCOPE

The Contractor shall furnish all labour, materials, tools, equipment, machinery operations and related items necessary and required for the full performance of the contract under this section, as shown on the drawings or as specified or reasonably implied or incidental to the construction.

8.2 GENERAL

The flooring shall be laid to the level except where slopes are called for on the drawings, in which case the slopes shall be uniform and arranged to drain into the indicated outlets. Particular care shall be exercised to ensure that all flooring, skirting etc., is perfectly matched for color and finish. The Contractor shall pave the areas indicated on the plans and schedule of finishes with materials therein called for. All work shall be laid to the best practice known to the trade.

The Contractor shall furnish for approval, samples of each type of floor, paving etc., the samples shall be of sizes and thickness as specified.

8.3 POLISHED GRANITE STONE SLABS FOR FLOORING, STEPS, STAIRS, CLADDING ON PANTRY AND WASH BASIN COUNTERS

Providing & fixing granite of approved quality and colour of required size mm double polished M/C cut of 20mm thick over floor surface in proper line. Level in CM 1:4 including finishing the joint with matching colour cement, polishing the top surface etc., complete as per instruction of EIC.

Granite stone shall be of best quality machine polished, Machine Cut and of approved colour, dense and homogenous in texture free from cracks, decay, weathering and flaws. The stone shall be of required size and shall be 20 mm thick. The material shall have to be got approved before and after procurement. Before laying flooring, the surface shall be paved and thoroughly hacked, cleaned off all mortar scales, loose materials etc., unless and until the surface is approved ready for paving, the laying shall not be done. The bedding with CM 1:4 proportions as directed with minimum thickness of 30 mm layer shall be laid evenly and to the required slope. The granite shall be truly and evenly set in thin paste of next cement apply to the bottom and to the prepared base. The stone then shall be tempted down with wooden mallet until they are exactly in true plane and in line with adjacent stone.
The stone shall be closed jointed and filled with matching cement. The entire surface of flooring shall be polished with machine up to mirror polish achieved including necessary use of antimony trioxide anhilix acid etc., as directed

8.4.1 FINISHING

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time; till moisture gets dried from its joints or top, Excessive troweling shall be avoided. Use of dry cement or cement and sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture, shall not be permitted.

8.4.2 CURING

The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty cement gunnies shall be avoided as the color is likely to be bleached with the remnants of cement matter from the bags.

9 CERAMIC TILES GLAZED AND MATT FINISH

Ceramic tiles in toilets and other areas where called for shall be non-slip ceramic tiles of approved make and shade. The tiles shall be laid to the pattern as approved. The tiles shall be of uniform color, true to size and shape and free from cracks, twists, uneven edges, crazing and other defects. The size and thickness of the tiles shall be as specified.

The tiles shall be laid as per the pattern shown in the drawings over a bed of specified thickness of cement mortar leveled to a true surface. The surface of the bedding mortar shall be left rough to provide bond for the tiles. A floating coat of thick cement slurry shall be laid over the screed to proper levels and the tiles set over the same firmly to correct line and levels.

The joints shall be filled and finished neat with cement paste pigmented to the shade of the tile. The joints shall be finished neat as directed and shall be straight, regular and uniform.

On completion, the surface shall be washed with water, rubbed with fine saw dust and left clean. The finished floor surface shall be true to required levels.

9.1 VTRIFIED TILES IN FLOORING AND SKIRTING

9.1.1 VITRIFIED TILES

The tiles shall generally conform to latest IS standards shall be procured by the contractor. They shall be flat, true to shape and free from cracks, crazing spots, chipped edges and corners. The glazing shall be of uniform shade and color shall be as shown in the drawings.

The tiles shall be of specified size and thickness as per drawing. The tolerance on facial dimension value shall be +/- 1.0mm and +/- 0.5 mm in thickness.

The top surface of the tiles shall be glazed. The glazed shall be either glossy or matt as specified. The underside of the tiles shall be completely free glazed in order that the tile may adhere properly to the base. Type edges of the tiles shall be preferably free form glaze, however, and glazed if unavoidable, shall be permissible on any one edge of the tile.

9.1.2 LAYING

The Vitrified tiles shall be laid over ferrow cement slab & it shall be cleaned, wetted Mortar of specified mix shall be spread to required thickness over a small area. The slab, washed clean, shall be laid on the mortar, pissed tapped, with a wooden mallet, and brought to required level the tiles shall be laid as per the pattern shown on the drawings or as approved.

It shall then be removed and laid a side. The top of the mortar shall then by corrected by adding fresh mortar at hollows. The mortar is then allowed to harden and cement slurry of paste like consistency shall be spread over the same at the rate of 1 bag per sqmt. area. The edges of the tile already laid shall be buttered with slurry of cement and pigment to match the shade of slabs. The tile to be laid shall then be placed back in position, pressed
and properly bedded in level with adjoining tiles with as fine a joint as possible. Other tiles are also laid in similar manner to correct levels with fine joints. The surplus slurry on the surface shall be cleaned off.

The tiles shall be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plans and lines.

The tiles shall be set in required pattern and butt jointed. The joints shall be as fine as possible. Where full size tiles cannot be fixed these shall be cut to the required size and their edges rubbed smooth.

9.1.3 CURING AND FINISHING

The joints shall be cleaned off of the grey cement grout with soft wire brush or trowel to a depth of 2mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the color of tiles. The surface shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with wooden mallet.

10 WATER-PROOFING FOR ROOF

The waterproofing shall be integral cement based water proofing treatment including preparation of surface as required for treatment of roofs, balconies, terraces etc. consisting of following operations:

a) Applying and grouting a slurry coat of neat cement using 2.75 kg/sqm. of cement admixed with proprietary water proofing compound conforming to IS: 2645 over the RCC slab including cleaning the surface before treatment.

b) Laying cement concrete using broken bricks/brick bats 25mm to 100mm size with 50% of cement mortar 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 over 20mm thick layer of cement mortar of mix 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope and treating similarly the adjoining walls up to 300mm height including rounding of junctions of walls and slabs.

c) After two days of proper curing applying a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS: 2645.

d) Finishing the surface with 20mm thick joint less cement mortar of mix 1:4 (1 cement: 4 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 and finally finishing the surface with trowel with neat cement slurry and making of 300 x 300mm square.

e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge.

With average thickness of 120mm & minimum thickness at Khurras as 65mm.

10.1 GUARANTEE

The treatment shall carry a guarantee for 10 years against leakage of water, dampness, seating and other defects. The treated roof shall be tested by allowing water to stand on the areas to a depth of 150 mm for at least 72 hours.

All guarantees shall be furnished in the format approved /Engineer-in-charge duly signed by the contractor and sub contractor.

10.2 SPECIFICATIONS FOR CURING

The finished surface shall be cured for at least 7 days.

10.3 KHURRAS
The Khurras shall be constructed before the brick masonry work in parapet wall is taken up, and it shall be 45 cm x 45 cm and shall be formed of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) unless otherwise specified in the drawings.

10.4 LAYING

A PVC sheet 1M X 1M X 400 micron shall be laid under the khurras and then cement concrete shall be laid over it to a minimum thickness of 3 cm with its top surface lower than the level of adjoining roof surface as approved.

10.5 FINISHING

The Khurras and sides of the outlet shall then be rendered with cement plaster of mix and thickness stipulated in the drawings. This shall be done when the concrete is still green and shall be finished with a floating coat of neat cement. The sides of the Khurras and sizes of finished outlet opening shall be as directed.

11 SPECIFICATIONS FOR PLASTERING WORK

11.1 SCOPE

The Contractor shall furnish all labour, materials scaffolding, equipment, tools, plants and incidentals necessary and required for the completion of all plaster work.

11.2 GENERAL

Plaster as herein specified shall be applied to all internal surface where called for. All plaster work shall be executed by skilled workmen in a workman-like manner and shall be of the best workmanship. The primary requirement of plaster work shall be to provide dense, smooth and hard enclosure and devoid of any cracks of the interior and/or exterior.

11.3 SCAFFOLDING

Double scaffolding having two seats of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. The contractor shall get the scaffolding approved.

11.4 CHASING AND BREAKAGE

Fixing of door and window frame, shall be completed before any plaster work is commenced on a surface. No chasing or cutting of plaster shall be permitted normally. However, if the same is felt unavoidable at places, written permission shall be obtained before cutting any such plaster. Broken corners shall be obtained before cutting any such plaster. Broken corners shall be cut back out less than 150 mm on sides and patched with cement mortar as directed. All corners shall be rounded to a radius of 80 mm or as directed.

11.5 PREPARATION

Masonry and concrete surfaces which call for application of plaster shall be clean, free from dust and loose mortar. Efflorescence if any shall be removed by brushing and scrapping. For masonry surfaces the joints shall be raked out properly, while the concrete surfaces shall be roughed by wire brushing and hacking to provide the key, thereby ensuring proper bond. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

11.6 CHICKEN WIRE MESH

Galvanized chicken mesh (22 gauge, 12 mm size) shall be provided at junctions of brick masonry and concrete members, to be plastered and other locations as called for, properly stretched and nailed with galvanized wire nails, ensuring equal thickness of plaster on both sides of the mesh. The width of the mesh shall be as approved by Engineer-in-charge. The chicken meshes wherever specified, shall be fixed in place before plastering.
11.7 Samples of each type of plaster shall be prepared well in advance of undertaking the work for the approval.

11.8 MORTAR
The mortar of the specified mix shall be used. Mortar shall be prepared as specified under “Brick Work”. It shall be made in small quantities, as required, and applied within 15 minutes of adding water to the plaster mix.

11.8.1 CEMENT:
Cement shall be as per specifications under “Concrete Work”.

11.8.2 WATER:
Water shall be as per specifications under “Concrete Work”.

11.8.3 SAND
For plaster work normally clean fine river sand shall be used. However, if specified in the drawing or schedule of finishes, coarse sand conforming to the specifications under “Concrete work” shall be mixed with fine river sand in proportion specified or directed.

11.8.4 WATER PROOFING COMPOUND
Chemicals as approved.

11.9 PLASTER
6mm thick plaster shall be completed before commencement of wall plaster. Plastering shall be started from the top and worked down towards the floor. To ensure even thickness and true surface, plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2 meters intervals over the entire surface to the plaster to serve as gauges. The surface of these gauged areas shall be truly in place of the finished plaster surface. The mortar shall be laid between the gauges with a trowel ensuring through filling of joints. The mortar shall be applied in a uniform surface slightly more than the specified thickness and then brought to a true surface, by working a wooden straight edge reaching across the gauge, with small upward and side movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive trawling or over working the float shall be avoided.

All corners, arises angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, junctions etc. Where required shall be done without any extra payment. Such rounding shall be carried out with proper templates to the sizes required. No portion of the surface shall be left out initially to be patched up late on. Grooves shall be provided at the junction of Ceiling and wall plaster without any extra cost. In suspending work at the end of the day, plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scraped, cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to be properly joined together. Plastering work shall be closed at the end of day on the body of the surface and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of the features such as pilasters, bands and cornices. Horizontal joints in plaster work shall not also occur on parapet tops and copings, as these invariably lead to leakages.

11.9.1 GROOVES
Wherever directed all joints between concrete and brick masonry besides other locations as called for shall be expressed by a groove cut in plaster at no extra cost.

11.9.2 FINISH
The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

11.9.3 CURING
Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages.

11.9.4 PRECAUTION
Any cracks which appear in the surface and all portions, which sound hollow when tapped or are found to be soft or otherwise defective shall be cut out in rectangular shape and redone as directed.

11.9.5 FLOATING COAT OF NEAT CEMENT
Where finishing with a floating coat of neat cement is specified in the drawings or directed, specification, for this item of work shall be same described above except for the additional floating coat which shall be carried out as below. When the plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg. per sq. mt. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix.

11.10 BEARING PLASTER
This shall consist of cement plaster 1:3(1 cement : 3 coarse sand) 20 mm thick finished with a coat neat cement laid on top of walls as bearing for RCC lintels, beams and slabs. When dry, a thick coat of lime wash shall be given.

12. SPECIFICATION FOR PAINTING WORK

12.1 OIL BOUND DISTEMPER

12.1.1 MATERIALS
Oil emulsion (Oil Bound) washable distemper (IS : 428) of approved brand and manufacture shall be used. The primer shall be of the same manufacture as distemper shall be diluted with water of any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day’s work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight’s work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by Engineer-in-Charge.

12.1.2 PREPARATION OF SURFACE
The surface shall be thoroughly cleaned of dust. Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sandpapering the same after it is dry.

Pitting in plaster shall be made good with plaster of Paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.
12.1.3 APPLICATION

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

12.1.4 SCAFFOLDING

The specifications in respect of scaffolding, protective measures shall be as described under white washing.

12.2 WATER PROOF CEMENT PAINT

12.2.1 MATERIAL

Cement paint of required colour and of approved brand and manufacture conforming to IS : 5410 shall be used. Before application of the cement paint the shade shall be got approved. Cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall comprise of adding further one part of water to mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer’s instructions shall be followed meticulously.

Cement paint shall be mixed in such quantities as can be used up within a hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish.

The lids of cement paint shall be kept tightly closed when not in use, as by exposure to atmosphere the cement paint rapidly become air set due to its hygroscopic qualities.

12.2.2 PREPARATION OF SURFACE

For new work, the surface shall thoroughly be cleaned of all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing. The surface shall be thoroughly wetted with clean water before the cement paint is applied.

12.2.3 APPLICATION

For new work, the treatment shall consist of a priming coat of cement paint following by the application of two or more coats of cement paint till the surface shows on even colour. For each coat, the entire surface shall be coated with the mixture, uniformly, with proper cement paint brushes in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

The subsequent coats shall be applied only after the previous coat has dried The finished surface shall be even and uniform and shall show no brush marks.

Enough cement paint shall be mixed to finish one room at a time The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day After each day’s work, the brushes shall be washed in hot water and hung down to dry Old brushes which are dirty or caked with painting shall not be used.

12.2.4 SCAFFOLDING

The specifications in respect to 12.1.1 scaffolding protective measures shall be as described above under white washing.

13. SPECIFICATIONS FOR ACRYLIC EMULSION PAINTING:

13.1 Workmanship:

13.1.1 Scaffolding:
Wherever scaffolding is necessary, it shall be erected on double supports ties together by horizontal pieces, over which scaffolding planks will be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed.
Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

13.1.2 Preparation of surface:

Preparation of surface shall in general be in accordance with, except that any unevenness shall be made good by applying putty (white cement based) mixed with water including up the undulation and then sand papering the same after it is dry.

13.1.3 Preparation of paint

The paint mix, shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be as per item description. The painting shall be laid evenly and smoothly by means of crossing and lying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternatively in opposite direction 2/3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off with constitute one coat.

The paint shall be applied by means of brush or roller.

Before starting painting with plastic emulsion paint, the prepared surface shall be reacted with two coats of primer consisting of cement primer whiting and plastic emulsion paint shall start only after the preceding coat has become sufficiently hard to resist brush marking. Subsequent coats of plastic emulsion paint shall also be started after the preceding coat is dried by evaporation of water content.

The surface of finishing shall present a flat, velvets smooth finish, even and uniform shade without patches, marks, paint drops etc.

13.1.4 Precautions:

i. Brushes shall be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush. Old brushes, if used shall be completely dried of turpentine / oil paints by washing in warm soap water.

ii. No oil base puttied shall be used in filling cracks / holes.

iii. Washing of painted surface shall not be done within 3-4 weeks of application.

13.1.5 Protective measures

Surface of distempering over existing distempered surface, the existing distempering shall be scrapped by steel scrapers leaving a clean surface.

All nails shall be removed. Pitting in plaster shall be made good with plaster of paris mixed with dry distemper of colour to be used. The surface then shall be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed.

The surface affected by moss, fungus, algae efflorescence shall be treated in accordance with IS 2395.

13.2 ACRYLIC COPOLYMER AGGREGATE FINISH

13.2.1 Material

It shall be an acrylic based textured wall coating consisting of quartz and silica aggregate, inorganic pigments and other additives to form a crack free, flexible, tough, water proof coating.
13.2.2 Preparation of Surface

The surface to be coated shall be cleaned and all dirt, dust, grease and loose particles shall be removed. Any old textures surface shall be removed with removing agent as per manufacturer’s instructions.

13.2.3 Application

Bonding agent and water shall be mixed first. Then the flakes / granules shall be added and mixed thoroughly and kneaded till no lumps are found. The dough shall be left for 20-30 minutes before starting application. The bonding agent flakes / granules and water shall be mixed in different ratios for different finishes as per manufacturer’s specifications.

The first application shall be by steel trowel. It shall be smoothened, if the specified finish required, by a plastic trowel.

13.3 VARNISHING

Varnishing of wood and wood based material shall be in accordance with IS 2338 (Part – II). Surface to be varnished shall be prepared to produce a smooth, dry and matt surface and all dust and dirt shall be removed from the surface.

The varnish shall be applied liberally with a bush and spread evenly over a portion of the surface with short light strokes to avoid fronting. It shall be allowed to flow out while the next section is being laid in. Excess, varnish shall be scraped out of the brush and then the first section be crossed, re crossed and laid off lightly. The varnish, once it has begun to set, shall not be retouched. In case of any mistake, the Varnish shall be removed and the work shall be started afresh.

Where two coats of varnish are applied, the first coat shall be hard drying under coating or flattening varnish which shall be allowed to dry hard and then be flattened down before applying the finishing coat. Sufficient time shall be allowed in between two coats.

When flat varnishing is used for finishing, a preparatory coat of hard drying under coating of flattening varnish shall first be applied and shall be allowed to harden thoroughly. It shall then be lightly rubbed down before the flat varnish is applied.

On larger areas, the flat varnish shall be applied rapidly, and the edges of each patch applied shall not be allowed to set, but shall be followed up whilst in free working conditions.

13.3.1 French polish

French polish shall conform to IS: 348. Suitable pigments shall be added to get the required colour. The surface to be French polished shall be rubbed down to smoothness with sand paper and shall be well dusted. Pores in the surface shall be filled up with fillers. A pad of woolen cloth covered by a fine cloth shall be used to apply the finish. The pad shall be moistened with polish and rubbed hard on the surface in a series of over lapping circles applying the polish sparingly but uniformly over the entire area to give an even surface. A trace of linseed oil may be used on the face of the pad for the purpose. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

13.4 PAINTING OF STEEL AND OTHER METAL SURFACES

13.4.1 GENERAL
Reference shall be made to the following Indian Standards: IS 2524, IS 1447.

13.4.2 Preparation of surface

The surface, before painting, shall be cleaned of all rust, scale, dirt and other foreign matter with wire brushes, steel wool, scrapers, sand paper etc. The surface shall then be wiped finally with mineral turpentine which shall then be removed of grease etc. The surface then shall be allowed to dry. In case of GI surface so prepared shall be treated with Mordant solution (5 liters for about 100 sq.m) by rubbing the solution generously with brush. After about half an hour, the surface if required shall be retouched and washed down thoroughly with clean cold water & allowed to dry.

13.4.3 Application of priming and paints

Approved quality primer and paint in specified no. of coats shall be applied as per manufacturer’s recommendations either by brushing or spraying. Each subsequent coat shall be applied only after the preceding coat is dried.

13.5 SYNTHETIC ENAMEL PAINT TO WOOD WORK

13.5.1 Synthetic enamel paint of approved brand and manufacture and of the required colour shall be used for the top coat and an under coat of shade to match the top coat as recommended by the manufacture shall be used.

13.5.2 One coat of specified paint of shade suited to the shade of the top coat shall be applied after rubbing with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dust off.

13.5.3 Top coats of specified paint of required shade shall be applied after the first coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

GRID FALSE CEILING SYSTEMS

ALUMINIUM GRID SYSTEM

Aluminum grid system for supporting false Ceiling tiles shall be of approved made and shall be perfectly leveled aligned at desired height and in accordance with the false Ceiling pattern as per drawings.

MATERIAL

a. Main Runner shall be of extruded anodized (25 micron) aluminum Tee sections of 25mm x 35mm size (approved make), 2.5 mm thick.

ERECTION

The grid system shall be assembled by interlocking the main and cross runners @ 600 mm c/c max. on both ways by means of aluminum angle cleats. The main runners shall be suspended from the Ceiling by means of 3 mm thick MS flat clamp fixed to main runners @ 1200 mm max. and fixed to 6 mm dia MS hook which again is fixed to the Ceiling. 3 mm thick MS flat clamp shall be connected to main runner with 25 mm long MS clamp with leveling nut and @ 1200 mm maximum. The MS hooks shall be suspended from the Ceiling by means of slotting in 25mm x 3mm thick MS flat, ‘L’ shaped, fixed to the slab by 12 mm dia Dash fasteners @ 1200 mm C/C. The overall grid system shall be rigid, in accordance with false Ceiling pattern, perfectly leveled and aligned at desirable height.

GI GRID SYSTEM

GI grid system for supporting false Ceiling tiles shall be perfectly leveled, aligned at desired height in accordance with false Ceiling pattern.

MATERIAL AND WORKMANSHIP
a. Wall Channels
Wall channels shall be made 0.5 mm thick GI of size 27 mm, one flange 20 mm and other 30 mm. Wall channels shall be fixed to peripheral walls by raw plugs / dash fasteners @ 450 mm C/C.

b. Intermediate Channels (main runners)
GI intermediate channels shall be 0.9 mm thick, of size 45 mm and with two flanges of 15 mm each. The intermediate channels shall be suspended from the soft @ 1200 mm with 25 mm x 0.5 mm GI hanger bolted to the channel and fixed to the Ceiling (by means of bolting to GI cleat fixed to the Ceiling with dash fasteners).

c. Sections (Cross runners)
GI channel shaped Ceiling sections shall be 0.5 mm thick having a knurled Web of 51.1 mm and two flanges of 26 mm each with lips of 10.5 mm. The Ceiling sections shall be fixed to the intermediate channels in perpendicular direction at 450 mm C/C with the help of connecting clips.

1.2 GYPSUM BOARD TILES:

Gypsum board shall conform to IS: 2095 The Gypsum boards used for false Ceiling shall have following properties

i Thermal Conductivity – 0.16 W / mk

ii Thermal Resistance
a. For 9.5 mm thick board – 0.06 m2 K/W
b. For 12.5 mm thick board – 0.08 m2 K/W
c. For 15 mm thick board – 0.09 m2 K/W

iii Fire Propagation
a. Fire Propagation
   Index of performance not exceeding 12 and a sub index not exceeding 6 (when each side is tested Separately to BS 476 Part – 6).

b. Surface spread of flame Class 1 (both sides) as / test to BS 476 Part – 7).

Gypsum boards shall be specified thickness, and of specified finish (painted / prelaminated). The Gypsum boards shall be screw fixed to the underside of false Ceiling grid system with 12.5 mm dry wall screw @ 230 mm C/C by drilling machine. Joint in the board shall be finished flush with fillers, finisher and primer as per manufacturer’s recommendation to give seamless finish.

Necessary cut-outs for Electrical / AC and other fixtures shall be provided with a framing of wall channels.

The finished false Ceiling shall be perfectly leveled and aligned, at desired height as per drawings.

Acoustical Ceiling

System Description
Standard Panels: - Suspended (New Fire- Rated) ceiling system consisting of acoustical panel ceiling suspension system as per ISO-4611. System shall be rated NRC (Noise Reduction Coefficient) in accordance with ASTM-E-84 as tested by an independent agency.
CAC : Ceiling Attenuation Class
LR : Light Reflectance Coefficient
NRC : Noise Reduction Coefficient
Delivery & Storage of Material
All material shall be delivered in their original unopened packages and stored in an enclosed shelter providing protection from damage and exposure to the elements.
Storage time of material at jobsite should be as short as possible and environmental conditions should be as near as possible to those specified for occupancy. Excess humidity during storage can cause expansion of material and possible warp, sag, or poor fit after installation.
Damaged or deteriorated materials should be removed from the premises. Immediately before installation, to stabilize tile and panels, store them at a location where temperature and humidity conditions duplicate those ambient during installation and anticipated for occupancy.

Environmental Condition:-
Installation of acoustic panels shall not begin until building is enclosed, permanent heating and cooling equipments is in operation, and residual moisture from plaster, concrete, or terrazzo work has dissipated.
Do not use ceiling panels in extreme of continuous high humidity, or areas exposed directly to weather or water.
Ceiling panels are sized and designed for use within the standard occupancy range of temperature and humidity 65-85°F (18-29*C), no more than 70% RH(Relative Humidity).
Humidity can greatly affect product dimensional ability and sag resistance. Sag can become noticeable during periods of high humidity lasting on a few hours.
Allow time for dimensional changes in ceiling panels stored at temperature/ humidity condition well outside of those recommended for service. With increase on temperature and humidity, these products expand 1/64 in./ft (4.3 mm/m) at 85°F (29*C)/90% RH) and may not fit into a fix grid.
Conversely, with decrease these products will be undersized but expand to normal when ambient conditions return.
For some pattern as detail, if perimeter panels must be cut smaller, the cut must be filled-rebated, or the wall angle must be lowered by (1/4”) (3/8”) Reveal depth.

Quality Assurance
Single source responsibility: to obtain life time ceiling system warranty, 30-years ceiling system warranty, colour match or ceiling panel and suspension system compatibility should be preferred.
Installer shall have successful experience in installation of suspended ceiling system on project with requirement specified.
Manufacturer will provide test certification for minimum requirements as tested in accordance with applicable industry standards and/or to meet performance standard specified by various agencies.
System performance following any substitution of materials or change in assembly design must be certified by the manufacturer.

Submittals
1. Reflected ceiling plans: Contractor shall submit a layout arrangement of ceiling design, dimensions and location of related integrated lighting and air distribution components.
2. Detail complete installation including suspension system, installation of related lighting and air distribution components, access requirements, sound absorption requirements, and fire rating requirements when applicable.
3. Submit manufacturer’s catalog cuts of standards drawings showing detail of system with project conditions clearly identified and manufacture’s recommended installation instructions.
4. 1% of amount of ceiling components installed.

Acoustical Wall Panel Specification for Standard Wall Panel
GENERAL
Contractor shall submit Shop Drawings showing fabrication and installation details for acoustical Wall panels, including plans, elevations, sections, details and attachment of other work.
Submittals: Furnish 12”x12” samples, showing manufacture full range of colors, texture and patterns available for each type of acoustical product specified.

Product Test Report: From a qualified testing agency indicating wall panels comply with requirements.

Qualification Data: For firms specified in “Quality Assurance” Article to demonstrate their capabilities and experience.
Product Certificates: Signed by manufacturer certifying that the products Furnished comply with requirements.

Manufacturer Qualification: Manufacture shall have a minimum of 5 years experience in production of specified products and shall furnish supporting documentation showing completed jobs of approximately the same size and scope.

Fire Test Reports: Provide acoustical wall panels with the following surface-burning characteristics as per ASTM E 84.

1. Flame Spread: 25 or less
2. Smoke Developed: 450 or less

Acoustical Test Report: Provide acoustical test report from a qualified testing agency.

DELIVERY, STORAGE, AND HANDLING

Protect Acoustical Wall Panels from excessive moisture when shipping, storing, and handling. Deliver in unopened skids and store in a dry place with adequate air circulation. Do not deliver material until all wet-work has been completed.

WALL PANELS, GENERAL

Acoustical Wall Panels shall be (5/8"-1"-1 1/2"-2" or custom)-6.0-7.0 lb. per cubic foot high-density fine fibered fiberglass. Manufactures standard panel construction, fully wrapped, hardened, panel manufactures standard full line of fabric.

Facing Material: Guilford of Maine FR 701 -Style 2100 -100% Polyester

Panel Thickness: (5/8", 1", 1 1/2", 2") see above

Noise Reduction Coefficient: (.55-.80-.90-1.00)

Panel Width: As indicated, up to 60” width maximum

Panel Length: As indicated, up to 10 feet long

CONSTRUCTION

The acoustical wall panel product shall be supplied in widths and lengths as indicated. All edges will be fully wrapped with mounting as indicated

MOUNTING

Back-Mounting Accessories: Manufactures standard accessories for securely mounting panels, of type and size indicated and complying with the following requirements:

1. Mechanically Mounted Edge-Reinforced Panels: Metal impaling clips designed to support weight of panels, mechanically attached to wall substrate according to manufactures standard pattern and Adhesively bonded to back of panel, with base support brackets where recommended by manufacture for additional support of panels.

FLAMMABILITY RATING

All components shall have a Class a Flammability rating per ASTM E-84: Surface Burning Characteristics of Building Materials, with a Flame Spread of 25 or less and Smoke Developed of 450 or less.

INSTALLATION

Install Acoustical Wall panels in locations indicated top edges level and in alignment with other panels. Comply with manufactures written Instructions for installation of panels using type of mounting accessories indicated or, if not indicated, as recommended by manufacture

CLEANING
After completion of installation of panels, remove dust and other foreign material according to manufacturers written instructions. Remove surplus material, rubbish, and debris resulting from panel installation, on completion of the work, and leave areas of installation in a neat and clean condition.

**GRC Technical Specifications**

**Work Includes:**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Providing and Fixing of G.R.C. Band of approved Pattern of Following Sizes as per Drawing and direction of Engineer in charge</td>
<td></td>
</tr>
<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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<tr>
<td>b) Providing and fixing of GRC Crown of approved Pattern of Following Sizes as per Drawing and direction of Engineer in charge</td>
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<tr>
<td>300x1000x300 mm</td>
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<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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<tr>
<td>c) Providing and fixing of GRC designed at columns base and loop as per Drawing and direction of Engineer-in-Charge</td>
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<tr>
<td>1400 mm dia</td>
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<tr>
<td>1000 mm dia</td>
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<tr>
<td>d) Providing and Fixing Of GRC Designed Moulding Of approved Design &amp; Pattern as per Drawing and Direction of Engineer in Encharge</td>
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<tr>
<td>1350 x250 mm</td>
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<tr>
<td>1300x150 mm</td>
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<tr>
<td>1650 x 250 mm</td>
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<tr>
<td>1600 x 150 mm</td>
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</table>

- **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 W/MK at 5% moisture content

**MARBLE FLOORING**

i) **Marble Slabs:** The marble shall be of approved shade and sources as mentioned in the Schedule of Quantities and their size and the thickness shall be as shown in the drawings and as approved by the Architect. They shall be of selected quality, dense, uniform and homogeneous in texture and free from cracks or other structural defects. It shall have even and crystalline grains. The surface shall be machine polished to an even and perfectly plain surface and edges machine cut true and square. The rear face shall be rough enough to provide a key for the mortar. No slab shall be thinner than the specified thickness at its thinnest part. The dimensions of the slabs shall be as specified. A few approved samples of finished slabs to be used shall be deposited by the contractor in the office of the EIC.

ii) **Mortar Bedding:** Cement mortar for bedding may be mixed manually or by a mechanical mixer as directed. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that
would interfere with the even bedding of the stones. Before spreading the mortar, sub-floor or base shall be cleaned of all dirt, scum or laitance and of loose materials and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with slabs within half an hour. The thickness of the mortar bedding shall be 50mm avg. thick (But not less than 20 mm thick). The proportion of mortar bedding shall be 1:4 cement mortars.

iii) Laying Marble Slabs:

Before laying, marble shall be thoroughly wetted with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed over as much area as could be covered with the slabs within half an hour. The specified type of marble slabs shall be laid to pattern as directed on the neat cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. Each slab shall be gently tapped with a wooden mallet till it is firmly and properly bedded. There shall be no hollows left. If there is a hollow sound or gentle tapping on the slabs, such slabs shall be removed and reset properly. The joints shall be hair fine in width and in straight line grouted with neat colored cement slurry to match the colour of the marble. The joints shall be struck smooth but there shall be no meaning over the mortar of the slabs, the edges of the adjoining slabs shall be in one plane. The flooring shall be kept undisturbed at least seven days and wet for 14 days. Marble flooring shall be given a final coat of wax polish of approved make.

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:

Vinyl chloride polymer

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**

<table>
<thead>
<tr>
<th>Property</th>
<th>Tolerance</th>
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<tbody>
<tr>
<td>Thickness</td>
<td>+ 0.15mm</td>
</tr>
<tr>
<td>Width</td>
<td></td>
</tr>
<tr>
<td>(i) 300mm square tiles</td>
<td>+ 0.2mm</td>
</tr>
<tr>
<td>(ii) 600mm square tiles</td>
<td>+ 0.4mm</td>
</tr>
<tr>
<td>(iii) 900mm square tiles</td>
<td>+ 0.6mm</td>
</tr>
<tr>
<td>Sheets and rolls</td>
<td>+ 0.1 per cent</td>
</tr>
</tbody>
</table>

**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/ sqm. 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-witched 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 200°C nor exceed 300°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 contact 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, 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.

**Mineral Fiber Ceiling**

Mineral Fiber Suspended Ceiling System with (Regular) EDGE TILES WITH 24mm Exposed GRID. The tiles should have Humidity Resistance (RH) of 99%, Minimum NRC 0.5, Light Reflectance \(\geq 83\%\), Thermal Conductivity \(k = 0.052 - 0.057\) w/m K, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7) in module size of 600 x 600 x 16mm with Bio Block coating on the face of the tile, suitable for Green Building application, with Recycled content of 38 - 41%. The tile shall be laid on with 24 mm wide T - section flanges having rotary stitching on all T sections i.e. the Main Runner, 1200 mm & 600 mm Cross Tees with a web height of 38mm and a load carrying capacity of 15.34Kgs/M². The T Sections have a Galvanizing of 90 grams per M². The Tile & Grid system used together should carry a 15 year warranty. Installation to comprise main runner spaced at 1200mm centres securely fixed to the structural soffit using suspension system (specifications below) at 1200mm maximum centre. The First/Last suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall. Flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre to form 1200 x 600 mm module. Cut cross tees longer than 600mm require independent support. 600 x 600mm module to be formed by fitting 600mm long flush fitting cross tees centrally between the 1200 mm cross tees. Perimeter trim to be wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres. The work of fixing rainwater pipes, grouting around mouth of rain water pipes and making khurra shall be done before starting the items of roofing. The roofing shall overlap the khurra surface by about 100mm. SUSPENSION SYSTEM accessories will be approved make consisting of M6 Anchor Fasteners or equivalent with Vertical Hangers made of Galvanized steel of size 26 x 26 x 25 x 1.2mm with a Galvanized Thickness of 80gsm, A pre Straightened Hanger wire of dia – 2.68 mm of 1.83 m length., thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner. The work including, , cutting / making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc wherever, required.

**GRANITE STONR FLOORING**
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

General

Granite Stone shall be of the type specified and the material promptly in accordance with specifications, it shall be hard sound durable and tough free from cracks, and defects like cavities cracks flaws holes etc. Before starting the work the contractor shall get the sample approved by the Engineer – in –Charge / architect.

Materials

Granite Standard: Granite shall comply Standard Specification for material characteristics, physical requirements, and sampling for selection of granite.

All granite shall be of standard architectural grade, free of cracks, seams, or starts, which may impair its structural integrity or function. Color or other visual characteristics indigenous to the particular material and adequately demonstrated in the sampling will be accepted provided they do not compromise the structural or durability capabilities of the material. Texture and finish shall be within the range of samples approved by the Engineer – in -charge.

Anchor Provision: Cut and drill sink provisions and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone in place.

Provide chases, reveals, ringlets, openings, and similar features as required to accommodate adjacent work.

Shop Drawings:

The Contractor shall submit: copies of required shop drawings to the Engineer-in-charge for approval. These drawings shall show all bedding, bonding, jointing and anchoring details, and the dimensions of each piece of granite. No final sizing or finishing shall be done until the shop drawings for that part of the work have been approved.

STONE FIXING

Proceed with the fixing of the stonework in accordance with Drawings and using skilled mechanics capable of proper handling of the setting of the stone and able to field cut where necessary with sharp and true edges. Set stone with joints uniform in appearance and stone edges and faces aligned tolerances indicated. Clean surfaces that are dirty or stained. Scrub with fiber brushes, and then rinse with clear water. Provide expansion, control, and pressure-relieving joints of widths and at locations shown on Drawings.

Cleaning

After installation and pointing or caulking are completed, the contractor shall carefully clean the granite, removing all dirt, excess mortar, weld splatter, stains, and/or other site incident defacement Stainless steel wire brushes or wool may be used, but the use of other wire brushes or of acid or other solutions which may cause discoloration is expressly prohibited. Fabricator should be contacted before cleaners other than detergents are used.

Protection of Finished Work

After the granite work is installed, the granite shall be properly and adequately protected from damage. Boxing or other suitable protection shall be provided wherever required, but no lumber which may stain or deface the granite shall be used. All nails used shall be non-corrosive. All granite work in progress shall be protected at all times during construction by use of a suitable strong, impervious film or fabric securely held in place.

Defective Work
Any area or piece of granite found defective it shall be removed, and to be patched or redressed for use. Nothing extra on this account will be entertained.

Related sections

All work related to this specification section should be coordinated with the works described in other specification sections, including:

- Mortar
- Joints
- Pointing
- Curing

Mode of Measurement

The finished work shall be measured correct to a centimeter in respect of length and breadth nearest to two places of decimal. The rate shall include the cost of all operations described above including the cost of materials, labors, designs of drawings, erection and testing, fabrication, erection, finishing, scaffolding, etc. No other claims of any kind pertaining to this work shall be entertained.

Rate

The rate shall include the cost of materials and labor required for all the operations described above.

Granite stone flooring with 18mm thick stone flooring (sample of shall be approved by Engineer-in-charge) over 20 mm (average) thick base of cement mortar 1:4 (1 cement: 4 coarse sand) laid and jointed with grey cement slurry including rubbing and polishing complete with:

GRANITE STONE SKIRTING/CLADDING

General

Granite Stone shall be of the type specified and the material promptly in accordance with specifications, it shall be hard sound durable and tough free from cracks, and defects like cavities cracks flaws holes etc. Before starting the work the contractor shall get the sample approved by the Engineer – in – Charge / architect.

Materials

Granite Standard: Granite shall comply Standard Specification for material characteristics, physical requirements, and sampling for selection of granite.

All granite shall be of standard architectural grade, free of cracks, seams, or starts, which may impair its structural integrity or function. Color or other visual characteristics indigenous to the particular material and adequately demonstrated in the sampling will be accepted provided they do not compromise the structural or durability capabilities of the material. Texture and finish shall be within the range of samples approved by the Engineer – in -charge.

STONE FIXING

Proceed with the fixing of the stonework in accordance with Drawings and using skilled mechanics capable of proper handling of the setting of the stone and able to field cut where necessary with sharp and true edges. Set stone with joints uniform in appearance and stone edges and faces aligned tolerances indicated. Clean surfaces
that are dirty or stained. Scrub with fiber brushes, and then rinse with clear water. Provide expansion, control,
and pressure-relieving joints of widths and at locations shown on Drawings.

Cleaning

After installation and pointing or caulking are completed, the contractor shall carefully clean the granite,
removing all dirt, excess mortar, weld splatter, stains, and/or other site incident defacements Stainless steel wire
brushes or wool may be used, but the use of other wire brushes or of acid or other solutions which may cause
discoloration is expressly prohibited. Fabricator should be contacted before cleaners other than detergents are
used.

Protection of Finished Work

After the granite work is installed, the granite shall be properly and adequately protected from damage. Boxing
or other suitable protection shall be provided wherever required, but no lumber which may stain or deface the
granite shall be used. All nails used shall be non-corrosive. All granite work in progress shall be protected at all
times during construction by use of a suitable strong, impervious film or fabric securely held in place.

Defective Work

Any area or piece of granite found defective it shall be removed, and to be patched or redressed for use. Nothing
extra on this account will be entertained

Related sections

All work related to this specification section should be coordinated with the works described in other
specification sections, including:

Mortar

Joints

Pointing

Curing

Mode of Measurement

The finished work shall be measured correct to a centimeter in respect of length and breadth nearest to two
places of decimal.

1. **Structural glazing**

**General**

1) Framing system
   By reputed manufacturers. For all types of members like brackets, mullions, transom etc.
2) Sealant
   As specified in the item of silicon sealant
3) Insulation
   50mm thick glass wool of minimum density 48kg/cum
   sandwiched with black polythene sheet 100 micron on one
   side and aluminium foil of 100 Micro on the other side or
   as specified by manufacturer at spandrel area. The surface
   after fixing insulation shall be plain without any
distortion.

Aluminium Powder coated extruded sections manufactured
4) Heat reflective Toughened Glass Brown or Grey Colon or any shade approved by the Client/ Engineer-in-Charge/ Architect.

SCOPE OF WORK

Preliminary Requirements

(i) The contractor shall design, test, fabricate, deliver, install and guarantee all construction necessary to provide a complete curtain wall system for the proposed building, all in conformity with the drawings as shown.

(ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawings.

(iii) The curtain wall system shall also include the following activities:

(a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure, windows etc.

(b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.

(c) All thermal insulation associated with the system

(d) All fire protection associated with the system

(e) All copings and closure and metal cladding to complete the system

(f) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.

(g) Isolation of dissimilar metals and moving parts.

(h) Anticorrosive treatment on all metals used in the system.

(i) Polyester powder coating aluminium sections.

(iv) The contractor shall also be responsible for providing the following:

(a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.

(b) Mock-ups, samples and test units.

(c) Performance testing of the curtain wall framing and glazing assembly.

(d) Co-ordination with the work of other trade.

(e) Insulation with glass wool 48 kg/ cum at spandrels area.

(f) Protection.

(g) All final exterior and interior cleaning and finishing of the curtain wall system.

(h) As built record drawings and photographs.

(i) Guarantees and warranties.

(j) All hoisting, scaffolding, staging and temporary services.

(k) Conceptualizing and design of a suitable maintenance system for curtain glazing.

(v) The water tightness and structural stability of the whole curtain wall system are prime responsibility of the contractor. Any defect or leakage found within the guarantee period shall be sealed and made good at all the risk and cost of the contractor.

(vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should be designed to accommodate thermal and building movements.

Quality Consideration and Other Activities

(i) The contractor while submitting the detailed design calculations should submit the following information on the quality of materials to be used and other aspects as detailed below:
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

(1) Metal quality, finishes and thickness
(2) Glass quality, coating and thickness and proposed manufacturer’s brand names
(3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer’s brand name and also the name of agency proposed for fabrication work
(4) Arrangement and jointing of components.
(5) Field connections especially mullion to mullion and transom to mullion.
(6) Fixing and anchorage system of typical wall unit together with structural calculations.
(7) Drainage system and provision in respect of water leakage in the curtain wall system
(8) Provisions for thermal movements.
(9) Sealant and sealing methods.
(10) Glazing method.
(11) Wind load and seismic load and any other specific load considered in the design
(ii) Design concept over lightening protection link-up system of the curtain wall for connection and incorporation into the lightening conductor system of the building (Lightening conductor system of the building to be done by any other agency)
(iii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

Tolerances

Any parts of the curtain wall, when completed, shall be within the following tolerances:

(1) Deviation from plumb, level or dimensioned angle must not exceed 3mm per 3.5m length of any member or 6mm in any total run in any line.
(2) Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.
(3) Change in deviation must not exceed 3mm for any 3.5m run in any deviation.

Test of Wind Pressure

(i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the “pressure chamber” at which the test unit is fixed.
(ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.
(iii) The variation of dynamic pressure shall be of any approximate sine curve line.
(iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.
(v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.
(vi) The deflection on the main structural parts in this condition shall not exceed:

(1) 1/175 of the span between supports or 20mm, whichever is less for vertical elements.
(2) 1/250 of the span between supports for horizontal elements.
(3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

Test of Lateral Deflection per Floor Height

(i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.
(ii) The deflection of every + 2.5mm shall be increased up to + 13mm on the test unit (static deflection test)
(iii) The dynamic deflection shall be applied up to ± 13mm.
(iv) The variation of dynamic deflection shall be of an approximate sine curve line, on period of 3 seconds.
(v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the same shall be observed.
(vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

**Water Tightness Test**

(i) Water shall be sprinkled to the ‘Test Unit’ under wind pressure.
(ii) Pressure shall not be applied to the test unit.
(iii) The volume of the sprinkling water in one minute shall be 5 litres per sqmt minimum (01.gal/ sq.ft.)
(iv) All water leakage and drainage system at the joint and the openable sash of the curtain wall system shall be observed from the outside of the chamber.
(v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.
   (1) Install the test unit.
   (2) Hold first water tightness test.
   (3) Hold test of wind pressure as described above.
   (4) Hold second water tightness test.
   (5) Lateral deflection test.
(vi) Water leakage shall not be observed inside at all parts of the test unit during first water tightness test.

**8mm thick laminated wooden flooring**

WOODEN LAMINATE FLOORING

Providing & fixing of EGGER laminate wooden flooring - Class 32(AC4) conforming to EN13329 standards .(No Asian Manufacturing), thickness of plank minimum 8mm, size of plank- 1291mmx193mm, HDF core board to be swell stop plus with minimum density of 930 kg/m3 according to and conforming to EN622 type 5 standard. Product to be PEFC, FSC & Blue Angel certifications. Fixing to be done using 2mm PE foam and 0.2mm vapor barrier. Product to offer 20 years Guarantee for Residential/domestic use and 5 years Guarantee for commercial usage according to manufacturers guarantee document (Equivalent to Floor Master).

Laminated wooden flooring should be glue less Just Click patented locking system. Classification of use 32/23 with a surface abrasion resistance of class AC4/ IP > 4.00, slip resistance class R- 10 conforming to DIN EN 51130 standard, Impact Resistance IC 2, Formaldehyde Emission E1, Light fastness Level 6, Flame resistance-Cfl, Castor chair Type W, heat passing resistance 0.07 m2 K/W, static indentation EN 433 < 0.01, surface soundness EN 13329 > 1.4,e of plank size 1291x193x8 mm laminated flooring will be Laid over hard surface (Cement sand aggregate screed).
PLUMBING & FIRE-FIGHTING WORKS
SCOPE OF WORK

Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in Plumbing/Fire fighting / Hot water Generator Drawings.

Without restricting to the generally of the foregoing shall include the following:-

a) Supplying & Fixing of Sanitary Fixtures.
b) Soil, Waste, Rain Water and Vent Pipes.
c) Water supply including Hot & Cold (Internal & External).
d) Pumps, water treatment & allied works.
e) External Sewerage system.
f) Storm Water Drainage System.
g) Hot water generator & allied system.

The Contractor must get acquainted with the proposed site for the works and study Specifications and Conditions carefully before Tendering. The work shall be executed as per programme approved by the Engineer-in-Charge. If part of site is not available for any reason or there is some unavoidable delay in supply of materials stipulated by the Owner, the programme of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.

Works area shall be the area shown in the drawing.

SPECIFICATIONS

Work under this contract shall be carried out strictly in accordance with Specifications attached with the Tender & as per C.P.W.D. specifications 1996 Volumes I to VI.

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 latest amendments as applicable in the contract.
Works not covered as mentioned above shall be carried out as per relevant Indian Standards Specifications or Codes of Practice.

The work shall be carried out strictly as specified in Drawings & Technical Specifications. In case of any ambiguity, the details of particular item as given in specification shall supersede the details in Drawings.

**EXECUTION OF WORK**

The work shall be carried out in conformity with the individual services drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

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 programmed.

On award of the work, Contractor shall submit a programmed 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 should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

**DRAWINGS**

All the 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.

Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

Contractor shall verify all dimensions at site and bring to the notice of the Architects or Engineer-in-Charge all discrepancies or deviations noticed. Architects decision shall be final.

Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small-scale drawings.

All drawings supplied with the Tender shall be returned in good conditions along with the Tender.

All drawings/sketches issued by the Architects/Consultant for the works are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

**INSPECTION AND TESTING OF MATERIALS**

Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

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 followings:-

- a) Theodolite
- b) Dumpy level
- c) Steel tapes
- d) Weighing machine
- e) Plumb bobs, Spirit levels, Hammers
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

f) Micrometers

Thermometers, Stoves

h) Hydraulic test machine

i) Smoke test machine

All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-in-Charge.

All Testing Equipment shall be preferably located in special room meant for the purpose.

METRIC CONVERSION

All dimensions and sizes of materials and equipment given in the Tender document are commercial metric sizes.

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.

REFERENCE POINTS

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 the work.

All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

SHOP DRAWINGS

The Contractor shall submit to the Engineer-in-Charge six copies of the shop drawings.

Shop drawings shall be submitted under following conditions:-

   i. Contractor shall prepare shop drawings of plumbing / Fire fighting / Medical Gases / Boiler / Sewerage treatment plant etc, for the entire hospital within four weeks of the award of work. These drawings shall be submitted to the Engineer-in-Charge for approval and the work shall be executed at site on the basis of these approved drawings.

   ii. Large scale drawings showing typical details for Toilets & Fixtures.

   iii. Equipment layout, piping and wiring diagram.

   iv. Structural supports/hanging/laying and jointing details for all types of pipes as required.

   v. Layout plans as required and for any changes in the layout of Plumbing / Architectural Drawings.

AS BUILT DRAWINGS

The Contractor shall maintain one as built copy of all Drawings, Specifications, Addenda variations, approved submittals, correspondence, and transmittals at the site in good order and readily available to the Owner and the Engineer-in-Charge. The As built Drawings shall be clearly and correctly marked and as built specifications annotated by the Contractor to show all changes made during the construction process at the time the changed Work is installed. No such changes shall be made in the Work unless previously authorized by the change order or by specific approval of deviations or revisions in submittals.

The Contractor shall prepare and furnish to the Architect / services consultant accurate as built drawings. Architect / Services consultant shall approve these drawings after due verification at site. After approval, the
contractor shall submit to Engineer-in-Charge, A1 size three (3) black line white paper prints as well as soft copy in form of CD of each drawing as part of close out documents. Project manager shall forward the same to the owner for their records and for maintenance and operation.

The as built drawings must have the following information:

The works as executed complete with:

- Run of all piping & diameters on all floors and vertical stacks.
- Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.
- Run of all water supply lines with diameters, locations, of Control Valves, Access Panels.
- Location of all Mechanical equipment with whole plant layout, piping connections and panels as erected.
- Details of supports left in place and locations of all services encountered.
- Complete schematic diagram of the installation, as installed.
- Complete Schematic flow diagram for Sewage treatment plant.
- Complete layout plan of Sewage treatment Plant.
- Hot water generator room layout and Schematic of the system

CONTRACTORS RATES

Rates quoted in this Tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage, sales tax on works contract 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.

Rates quoted are for all heights and depths required for this work.

All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-in-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials.

TESTING

Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

Tests shall be performed in the presence of the Engineer-in-Charge / Consultant.

All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

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.

Contractor shall provide all labour, equipment and materials for the performance of the tests.

Contractor shall afford all the expenses for the offsite testing of material and equipments.

SITE CLEARANCE AND CLEANUP
The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

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 at Contractors risk and cost.

LICENSE AND PERMITS

Contractor must hold a valid Plumbing license issued by the Municipal Authority or other competent authority under whose jurisdiction the work falls.

Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to water supply, sewerage, drainage and fire fighting system. He shall also be responsible for co-ordination for getting the approval, with other agencies working on the project relating to their scope of work.

Contractor shall obtain No Objection Certificate before commencement of work, from the local authorities all related to his work as required for the building.

Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

CUTTING & MAKING GOOD

No structural member shall be chased or cut without the written permission of the Engineer-in-Charge.

GENERAL REQUIREMENTS

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 Drawing, Specifications and Drawings.

All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/Interior designer’s requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge.

All Fittings and Fixtures shall be fixed in a neat workmanlike manner true to Levels and Heights shows 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 Contractors cost.

When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.
Supporting and Fixing Devices

The contractor shall provide all supporting and fixing devices necessary to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly look in the final assembly. Where the location demands, the Architects may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply fixing devices and install them complete with appropriate vibration isolating pads, washers and gaskets.

Final Installation

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building piping system and the sanitary fixtures shall be through proper unions and flanged 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 true 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 arranged as to give visible warning and discharge. A check shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

Joints/gaps between all sanitary appliances/fixtures and the floor/walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of color and shade to match that of the appliances/fixture and the floor/wall to the extent possible.

Protection against Damage

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, crazing, staining breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all 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.

EUROPEAN W.C.

European W.C. shall be wash down, single or double siphonic type, wall mounted set, flushed by means of exposed cistern, as specified in Drawing. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

Each W.C. 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 provided with 110mm dia (OD) PVC connector connecting the ceramic outlet of W.C.
INDIAN W.C.

Indian W.C. pan shall be Orissa pattern of size as specified in the Drawing. Each W.C. shall be provided with a 100 mm dia cast iron or porcelain P or S trap with or without vent horn.

W.C. shall be flushed by means of an exposed or concealed type flush valve or as specified in Drawing.

The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) joints between W.C. and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with an approved rubber joint.

URINALS

Urinals shall be flat back large white glazed Vitreous China of approx. size 590x390x375mm.

Flat back Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge.

Flat back urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.

Urinals shall be flushed by means of sensor operated flush system.

Waste pipes for urinals shall be of the following:

G.I. Pipes

Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-Charge. Specifications for waste pipes shall be same as given in Sub Section.

FLUSHING CISTERN

Flushing cistern shall be concealed or Exposed type design for low volume dual flushes 3 Ltrs & 6 Ltrs as directed by Engineer-in-Charge or mentioned in the drawing.

LAVATORY BASIN

Lavatory Basins shall be white glazed vitreous china of size, shape and type as indicated in architectural drawings.

Each Basin shall be provided with MS. or C.I. brackets and clips and the basin securely fixed to wall. Placing of Basins over the brackets without proper securing and fixing shall not be accepted.

Each Basin shall be provided with 32mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain, 32mm dia C.P. Brass Bottle Trap with C.P. pipe to wall and flange.

Each basin shall be provided with CP brass push type self closing pillar tap or Single hole Mixing Fitting as mentioned in the drawing.
Basins shall be fixed at proper heights as shown on architecture drawings. If height is not specified, the rim level shall be 79 cms above the floor or as directed by Engineer-in-Charge.

SINKS

Sinks shall be of precast Terrazzo marble or White Glazed fire clay or vitreous china or stainless steel or any other material as specified in the architectural drawing.

Hand Wash Sinks and Process Sinks shall be of stainless steel.

Each sink shall be provided with M.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40 mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Engineer-in-Charge.

Fittings for sinks shall be mixing fittings or as specified in the architectural drawing.

SHOWER SET

Shower set shall comprise of single lever mixer adjustable hand shower.

Each shower set shall also be provided with Overhead C.P. shower with 100mm long arm with flange of approved quality.

Concealed stop cocks wherever required 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.

ACCESSORIES

Accessories shall be of any of the following types:

- **Towel rails**
  Towel rail shall be C.P brass of size 610mm long and 20mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.

- **Towel rings**
  Towel rail shall be C.P brass of size 150mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.

- **Toilet paper holder**
  Toilet paper holder shall be of Satin finish stainless steel AISI 316 grade wall mounted type fixed to wooden cleats with C.P. brass screws.

- **Hand Dryer**
  Hand dryer shall be of best quality, to be operated with 230 volts, single phase, with fully hygienic condition, with all accessories and fixing in the wall as mention in the Architectural drawing or as directed by Engineer-in-Charge.

- **Coat hooks**
  Coat hooks shall be of satin finish stainless steel AISI 316 grade wall mounted coat hooks fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

- **Soap dispensers**
Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.

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. The flange of the recessed fixture shall cover the recess in the wall fully.

Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge.

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 Engineer-in-Charge.

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.

**URINAL PARTITIONS**

Urinal partitions shall be white glazed vitreous china or 25mm/40 mm thick marble of size of 690x325mm.

Porcelain 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 Engineer-in-Charge.

**TOILET FOR THE DISABLED**

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as per the NBC Norms for Disable Persons architectural drawing or as directed by the Engineer-in-Charge.

Stainless steel grab bars of 600mm long suitable for expose mounting and penned non-slip gripping surface shall be provided in washroom for disabled persons. The flushing cistern shall be provided with chromium plated long handles.

**TESTING AND ACCEPTANCE**

Testing is done as per BS-5572 of Make & Model of Sanitary fixture & fittings

**INTERNAL DRAINAGE SOIL, WASTE & VENT PIPES**

**SCOPe OF WORK**

Work under this section shall consist of furnishing all labor, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and as directed by the Engineer-in-Charge.

Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:-

Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.
Connection of pipes to Gully Traps & Manholes etc.

Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads as specified.

Waste pipes connections from all Fixtures e.g. wash basins, sinks, urinals and kitchen equipments.

Testing of all pipes and connection joints.

**GENERAL REQUIREMENTS**

All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. (false-ceiling) shall consist of uPVC, SWR Pipe.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

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.

Pipes shall be securely fixed to walls and s by suitable clamps at intervals specified. Pipes shall as far as possible be kept 50mm clear of wall.

Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

Every waste pipe shall discharge above the grating of properly trapped gully. Contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided it shall be ensured that at-least one washbasin/washing trough is connected to such floor traps to avoid drying of water seal in the trap.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipe.

All works shall be executed as directed by Engineer-in-Charge.

**Soil, Waste & Vent Pipes**

a) The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in IS: 5329, having separate pipes for waste from kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains. Waste stacks have been provided with a “P” trap at basement.

b) All waste water from AHU’s, A.C. plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.

c) Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement or to an external manhole directly wherever feasible as shown on the drawings.

d) All soil and waste from areas below general ground level (Basements) will be collected in sumps and pumped into sewer lines.

e) Anti-siphonage pipe (ASP) shall be provided for soil fittings on vertical stacks. It may also be provided for waste lines where shown on the drawings.

f) Vent pipes shall be provided at all sewer lines at the starting manholes.

g) Waste pipe used in kitchen area shall be Cast Iron Pipes. All pipes shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron pipes conforming to IS:3989.

h) Jointing of pipe: All CI Pipe shall be joint with Drip seal PJS – 43. It is a salient manufactured in two colours “Black” and “White”, and can be used for sealing of C.I Pipe joints. The density of Drip Seal PJS – 43 should be 1.95 grams / c.c.
i) Mixing & Application: The Drip seal in two different colors is mixed homogeneously in the supplied packets. In cold conditions both unmixed packets are to be heated in Sun or heated to room temperature (25° C) to make them more workable for mixing. The pipe joint is cleaned to make it free from dust, grease, oil, cement splashes and all other foreign matters and contaminants. The joint is made dry. Hemp yarn is provided as usual in pipe joint as back filler. Force the mixed compound into the lap of pipe joint with Caulking tool, MS Flat piece or by Hand. Proper pressing of compound is necessary to avoid air entrapment. The joint is not to be disturbed till the compound is hardened. The mixed compound has a life of 30 to 40 minutes and should be used within this consumption period.

<table>
<thead>
<tr>
<th>Diameter of Pipe (mm)</th>
<th>Consumption per joint (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>130 to 150</td>
</tr>
<tr>
<td>80</td>
<td>150 to 170</td>
</tr>
<tr>
<td>100</td>
<td>200 to 250</td>
</tr>
<tr>
<td>150</td>
<td>250 to 300</td>
</tr>
</tbody>
</table>

Rainwater Pipes

a) All terraces shall be drained by providing down-takes rainwater pipes.

b) A separate piped drainage system for slopping roof with leaders shall be provided.

c) Rainwater pipes are separate and independent connected to the external storm water drainage system as shown on the drawings.

d) Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.

e) Any dry weather flow from waste appliances, AHU’s pump rooms, shall be connected to the sewerage system only.

Balcony/Planter drainage

Open balconies, terraces, planters and formal landscape areas will be drained by a separate pipe connected to external storm water drainage system.

uPVC pipes for SWR system (for soil waste and rain water)

**Pipes**
- All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 13952 type B for soil & waste and of type A for rain water.
- Pipes shall be joined by approved type of socket and ‘O’ rubber ring (confirms to I.S. 5382) joints with rubber lubricant.

**Fittings**
- Fittings shall conform to the Indian Standard recommended for the 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.
- Fittings shall be of the required degree of curvature with or without access door.
- Connection from a vertical stack or position to a horizontal line shall be made only by a “Y” junction.

**Fixing**
- All vertical pipes shall be fixed truly vertical to walls with approved type of uPVC saddle clamp. 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). However shaft where
more vertical pipes run, the pipes may be fixed to the slotted angle/channel supports fixed to walls at intervals specified here under:-

- Horizontal pipes running along shall be fixed on **galvanized structural adjustable clamps** (Clevis 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.

- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-in-charge for making such provisions in the Structure as necessary. All damages shall be made good to restore the surfaces at no extra cost.

**Clamps**

- Holder bat clamps shall be of standard design and fabricated from **galvanized M.S. standard flats** 40x3 mm thick and 12 mm dia M.S. Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.

- Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with **galvanized 40x3 mm flat iron "U" type clamps** with anchor fasteners of approved design or 6 mm nuts and bolts.

- For SWR pipes conforming to IS 13592 shall be clamped to wall with approved type of uPVC saddle clamp/ U-clamp or as given in the Bill of quantities.

- Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats as per detailed drawing. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.

- Galvanized 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 schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.

- Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.

- For sleeves, anchor fasteners and clamp spacing chart shall be as follows:

**CLAMP AND PIPE SUPPORT SPACING**

**Traps**
Floor traps

Floor traps shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and main waste pipes in toilets having 150 mm sinking shall run below slab and shall be supported from the below. The trap and waste pipes in sunken area (where required) shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1 : 2 : 4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cms of the required depth.

Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent shall be fixed as specified for floor traps.

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 inlet fitting fabricated from uPVC pipe without, with one, two or three inlet sockets fixed on side to connect the waste pipe. Joint between waste and hopper inlet socket of the trap shall be joined with solvent cement recommended by the manufacturer. Inlet shall be connected to a uPVC. P or S trap. Floor trap inlet hoppers and the traps if set in cement concrete blocks as specified in para above without extra charge. uPVC multi-inlet trap can be used where ever possible to be decided by the Engineer-in-Charge.

Trap & Seals

All traps shall be self cleaning design and the seal depth shall be as specified below wherever the traps are not integral with the appliances:

<table>
<thead>
<tr>
<th>Appliance or ware</th>
<th>Material</th>
<th>Trap Type</th>
<th>Seal depth(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lavatory /wash basin</td>
<td>C.P. cast brass</td>
<td>32 mm dia Bottle</td>
<td>75 mm</td>
</tr>
<tr>
<td>Sink</td>
<td>C.P. cast brass</td>
<td>40 mm dia Bottle</td>
<td>75 mm</td>
</tr>
<tr>
<td>Kitchen floor drain of fabricated drain boxes</td>
<td>uPVC/C.I.</td>
<td>75/100 mm dia ‘P’ or ‘S’</td>
<td>50 mm</td>
</tr>
<tr>
<td>Urinals</td>
<td>uPVC/C.I.</td>
<td>100 mm dia ‘P’ or ‘S’</td>
<td>50 mm</td>
</tr>
<tr>
<td>AHU’s</td>
<td>uPVC/C.I.</td>
<td>75 mm dia ‘P’ or ‘S’</td>
<td>50 mm</td>
</tr>
</tbody>
</table>

Floor Gratings

Floor and urinal traps shall be provided with 100-150mm square or round C.P./ Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm.

Jointing
Pipe to pipe and pipe to fitting (SWR) joint shall be with ‘O’ rubber ring as recommended by the manufacturer. Jointing with solvent cement shall be applied to uPVC waste pipes (confirming to I.S. 4985) and fittings or as recommended by the manufacturer’s.

Cleanout Plugs (on soil pipes)

32.6.1 uPVC Clean out pipe 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 pipe shall terminate flush with the floor levels.

32.6.2 Cleanout on Drainage Pipes

Cleanout pipe shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-Charge Cleanout pipe shall be of size matching the full bore of the pipe but not exceeding 160 mm OD.

Cleanouts at level pipe shall be provided with a bend terminating at floor level above. The cap of the cleanout pipe shall have a cap flush with floor.

Waste pipe from appliances

General

a) Waste pipe from appliances e.g. wash basins, sinks and urinals shall be of uPVC pipes 40, 50 or 63 mm OD conforming to IS:4985 class II (6 kg/cm²) shown on the drawings.

b) All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per the pipe spacing chart given in section

Encasing Pipe in Cement Concrete

uPVC soil and waste pipes and drainage under floor 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 one meter.

Testing

Testing procedure specified below apply to all soil, waste and vent pipes above ground including pipes laid along basement.

Entire drainage system shall be tested for water 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. All testing equipment/motors etc. shall be certified for its calibration by an approved laboratory.

All materials obtained and used on site must have manufacturer's Hydraulic Test Certificate for each batch of materials used on the site.

Testing Soil, Waste and Rainwater Pipes

Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for
blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.

After installation all connections from fixtures, vertical stacks and horizontal drains including pipes along shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. Rectify and replace where required.

Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-Charge and signed by both.
SECTION – III EXCAVATION FOR PIPE LINE
EXCAVATION
The excavation for pipe works shall be open cutting unless the permission of the Engineer-in-Charge for the ground to be tunnelled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer-in-Charge may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

Opening out Trenches
In excavation the trenches, etc. the solid road metal ling, pavement, curbing 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 shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-Charge and of the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence of trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-Charge shall order to the contrary.

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 Engineer-in-Charge.

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 Engineer-in-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

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 or cess pool, 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.

Excavation to be taken to Proper Depths
The trenches shall be excavated to such a depth that the pipes shall rest on concrete or on firm bedding as described in the several clauses relating to these so that the inverts may be at the levels given in the sections. In bad ground, the Engineer-in-Charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra at rates laid down for such works in the schedule, if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-Charge the extra depth shall have to be filled up with concrete 1:5:10 mix (1 cement: 5 fine sand: 10 stone aggregate 40mm nominal size) at the Contractor’s own costs and charges to the requirements and satisfactions of the Engineer-in-Charge.

Refilling
After the pipes 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 filling in the haunches and upto 75 cms above the crown of the sewer 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 Engineer-in-Charge shall otherwise direct.

**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, beams, 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 expenses and charges, repair and make good and damage done to buildings and other property. If in the opinion of the Engineer-in-Charge he fails to make good such works with all practicable dispatch, the Engineer-in-Charge shall be at liberty to get the work done by the Contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.

**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.

**Timbering of Sewer and Trenches**

The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close, timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their waling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and will be accountable for the sufficiency of all timbering, branches, sheeting and piling used as also for all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

**Shoring of Buildings**

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

**Removal of Water from Sewer, Trench etc.**

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.
Width and Depth of Trench

The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.

SECTION – IV WATER SUPPLY SYSTEM (COLD & HOT)

SCOPE OF WORK

Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings & specified hereinafter.

Without restricting to the generality of the foregoing, the water supply system shall include the following:-

a) Municipal water connection including water meter up to U.G. water tanks.
b) Piping from tube well to raw water tank
c) Distribution mains from hydro pneumatic system to all fixtures and appliances for cold water to buildings,
d) Distribution system from overhead tank to single toilet in the building,
e) Distribution mains from hydro pneumatic system to all fixtures and appliances for flushing water to buildings.
f) Excavation and refilling of pipes trenches.
g) Control valves, masonry chambers and other appurtenances.

• All water lines to different parts of building and making connection from source etc.
• Pipe protection and painting.
• Providing Hot water supply and return lines and insulation of hot water pipe lines.
• Control valves, masonry chambers and other appurtenances.
• Connections to all toilets kitchen equipments, tanks and appliances.
• Excavation and refilling of pipe trenches, wherever necessary.
• Trenches for taking pipe lines for these services if required.

GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

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.

As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.
Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and s by suitable clamps at intervals specified.

As far as possible, all piping inside the buildings shall run either concealed or embedded. Outside the buildings the piping shall be installed at least 60 cms below finished grade. All galvanized steel piping embedded either in trenches or in concrete and masonry work shall be tightly wrapped 1 mm thick fiberglass tissue laid in bitumen.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

**Water Supply System**

Contractor should study the site plan and water supply system diagram for an overview of the system.

**Source**

a) Water supply will be acquired from Municipal water mains through a service connection

b) Additional water supply will be obtained from captive tube-wells within the site. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank.

Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independently connected to a different pumping system.

**G.I. PIPES & FITTINGS**

All pipes outside the building and pipes running at basement level shall be galvanized steel tubes conforming to IS: 1239-1979 of class specified. When class is not specified they shall be medium class.

Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer’s trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions and Bushes. Fittings shall be of IS: 1879 - (part I to X) 1975.

Pipes and fittings shall be jointed with threaded fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the or floors and other as shown on drawings.

**CLAMPS**

G.I. pipes in shafts and other locations shall be supported by galvanized clamps of design approved by Engineer-in-Charge Pipe in wall chases shall be anchored by iron hooks. Pipes at level shall be supported on structural clamps fabricated from galvanized structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.
Pipe hangers shall be provided at the following maximum spacing:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Pipe Dia (mm)</th>
<th>Hanger Rod Dia (mm)</th>
<th>Spacing between Supports (Mtr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upto 25</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>32 to 50</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>65 to 100</td>
<td>12</td>
<td>2.4</td>
</tr>
<tr>
<td>4</td>
<td>125 to 150</td>
<td>16</td>
<td>3.6</td>
</tr>
<tr>
<td>5</td>
<td>200 to 300</td>
<td>19</td>
<td>5.3</td>
</tr>
</tbody>
</table>

UNIONS
Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge.

FLANGES
Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

TRENCHES
The galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes 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>15mm to 50mm</td>
<td>30 cms</td>
<td>60 cms</td>
</tr>
<tr>
<td>65mm to 100mm</td>
<td>45 cms</td>
<td>75 cms</td>
</tr>
</tbody>
</table>

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.
When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

**PAINTING**

All pipes above ground shall be painted with one coat of Red Lead and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard color code specified by Engineer-in-Charge.

All pipes in chases and below floor shall be provided with Anti-corrosive treatment.

**PIPE PROTECTION**

Where specified in the Drawing all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe.

**Sand Filling**

All G. I. pipes in trenches shall be protected with fine sand 150 mm all around before filling in the trenches.

**GUNMETAL VALVES**

Valves 65mm dia and below shall be heavy Gunmetal Full way Valves or Globe Valves or Ball valves conforming to IS: 778-1971 of 20 Kg/cm2 class. Valves shall be tested at manufacturer’s works and the same stamped on it.

All Valves shall be approved by the Engineer-in-Charge before they are allowed to be used on work.

**SLUICE VALVES**

All valves 80mm dia and above shall be C.I. Double Flanged Sluice Valves. Sluice valves shall be Cast Iron double flanged, with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and Cap Top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with Cap Tops.

Sluice valves shall be of best quality conforming to IS: 780-1969 of class specified.

- Joints for double flanged sluice valves shall be made with suitable Tail/socket pieces on the pipeline and flanges joints made with 3 mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.
- Sluice valves shall be installed at all branches and as shown on the drawings.
Scour Valves:

Scour valves shall be C.I. sluice valves as specified above. They shall be installed at the lowest level or tail end of the system as shown on drawings and directed by Engineer-in-Charge.

Air Release Valves

- Air release valves shall be single acting type air valves with Gunmetal body and bronze/gunmetal internal parts and plastic float.
- Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

INSULATION

For Chased Internal Pipes

Hot water pipes fixed in chase shall be thermal insulation over hot water pipes with 9mm thick nitrile or approved equivalent thermal insulation tubing, a elastomeric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m°k @ 40deg C over pipes.

For Exposed Piping

Exposed hot water line laid in trenches, exposed in shafts, on terrace and along level shall be thermal insulation over hot water pipes with 9mm thick nitrile/ polyolefin or approved equivalent thermal insulation tubing, a elastomeric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m°k @ 40 deg C over pipes. With Aluminum Cladding/ protective coating of resin hardener paint with fiber cloth (FRP)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Pipe Size (MM)</th>
<th>Thickness of Nitrile Rubber Insulation (MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 to 25</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>32 to 80</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>100 &amp; above</td>
<td>19</td>
</tr>
</tbody>
</table>

Anchor Block

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

CPVC PIPES
All pipes inside the buildings and where specified, outside the building shall be CPVC pipes tubes conforming to IS 15778:1996. Specific Gravity ASTM D 792 at 23°C should be 1.55 as specified. With Tensile Strength as per ASTM D 638 at 23°C should be 55N/mm².

Joining Pipe & Fittings

Cutting

Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

Deburing / Beveling

Burr and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fitting during assembly.

Fitting Preparation

A clean dry rag/cloth should be used to wipe dirt and moisture on the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

Solvent Cement Application

Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. CPVC schedule 40 & 80 heavy bodied CPVC solvent cement only should be used confirming to ASTM-F493.

Assembly

After applying the solvent cement on both pipe and fitting socket, pipes should be inserting into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approx) in order to allow the joint to set up.

An even bead of cement should be evident around the joint and if this bead is not continuous, remake the joint to avoid potential leaks.

Set & Cure times:

Solvent cement set & cure times shall be strictly adhered to as per the below mentioned table:

Minimum Core prior to pressure testing at 150 PSI

<table>
<thead>
<tr>
<th>. No.</th>
<th>Ambient Temperature during Core period</th>
<th>Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>½” to 1”</td>
</tr>
<tr>
<td>1</td>
<td>Above 15 deg C</td>
<td>1 Hr</td>
</tr>
<tr>
<td>2</td>
<td>4 – 15 deg C</td>
<td>2 Hrs</td>
</tr>
<tr>
<td>3</td>
<td>Below 4 deg C</td>
<td>4 Hrs</td>
</tr>
</tbody>
</table>

Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 PSI (10 Bar) for minimum 24hrs. During pressure
testing the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using coupler.

**Transition of CPVC to Metals**

When making a transition connection to metal threads, special brass/plastic transition fitting (Male & Female adopters) should be used. Plastic threaded connection should not be over torque hard tight plugs one half turn should be adequate.

**Threaded Sealants**

Teflon tapes shall be used to make threaded connection leak proof.

**Hangers & Supports**

For horizontal runs, support should be given at 3 ft (90 cms) intervals for diameter of 1” and below and at 4 ft (1.20 mtr) intervals for larger size.

Hangers should not have throw or sharp edges which come in contact with the tubing and shall be of GI.

Support should be as per the below mentioned table:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Size of Pipe Inch</th>
<th>210C Ft</th>
<th>490C Ft</th>
<th>710C Ft</th>
<th>820 C Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>½”</td>
<td>5.5</td>
<td>4.5</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>¾”</td>
<td>5.5</td>
<td>5.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>1”</td>
<td>6.0</td>
<td>5.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>11/4”</td>
<td>6.5</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>5</td>
<td>11/2”</td>
<td>7.0</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>2”</td>
<td>7.0</td>
<td>6.5</td>
<td>4.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc shall be made of CPVC by licensee.

The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from ½” up to 2” pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2”, a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493. **PVC solvent cement should not be used.**

**Concealed Plumbing**
All internal concealed plumbing for water supply shall be done with CPVC pipes. The pipes & fittings shall conform to CTS (Copper Tube Size) SDR-11 as per ASTM D2846. All pipes and fittings from ½” up to 2” shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

**Installation procedure**

All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer’s specifications.

**VALVE CHAMBERS**

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) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved or as specified in Drawing and in drawings including excavation, back filling complete.

**WATER METERS**

Water meters of approved make and design shall be supplied for installation at locations as shown in drawing. The water meters shall meet with the approval of the local municipal authorities. Suitable valves and chambers to house the meters shall also be provided along-with the meters.

All meters shall conform to Indian Standard IS: 779-1978 (Water meters-domestic type) and IS: 2373-1981 (water meters-bulk type). Where called for water meters shall be located in masonry chambers of appropriated size.

**PIPE HANGERS BRACKETS ETC.**

Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths which are not embedded over their entire run. The hangers and brackets shall be of adjustable heights and primer coated with red-oxide primer clamps. Collars and saddles to hold pipes shall be provided with suitable gaskets. The brackets and hangers shall be of Mild Steel designed to carry the weight of pipes safely and without excessive deflections.

All pipes and fittings shall be supported near every joint and half-way through every pipe length unless otherwise specified. Where called for, pipe hangers shall also be supplied with proper sound and vibration dampening devices to minimize noise and vibration transmission.

**TESTING**

All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm² in any case and with the consent of Engineer-in-Charge.

Pressure shall be maintained for a period of at least TWELVE hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.
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 during the defects liability period without any extra cost.

After completion of the water supply system, Plumbing 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.

CONNECTIONS TO WATER TANKS

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflow, control valves and all such other piping connections including level indicator to water storage tanks as called for.

Suitable float controls of an approved make, securely fixed to the tank independent of the inlet pipe and set in a position so that water inlet into the tank is cut off when filled up to the water line. The water level in the tanks shall be adjusted to 25mm below the lip of the overflow pipe. Full way gate/ball valves of approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe.

The overflow pipe shall be so placed as to allow the discharge of water being readily seen. The overflow pipe shall be of size indicated. A stop valve shall also be provided on the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning. The ball valves shall conform to Indian Standard IS:1703-1968

CONNECTIONS TO MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of all mechanical equipment supplied by other agencies shall be carried out by the Plumbing contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturer’s instructions and the directions of the Engineer-in-Charge. The equipment to be supplied by other agencies consists mainly of Kitchen, Laundry, Air-conditioning, Water Treatment and other similar equipment. The connections to the various equipment shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirements of equipment suppliers, under the directions of the Engineer-in-Charge. The various aspects of connection work shall be executed in a manner similar to the work of respective trades mentioned elsewhere in these specifications.

DISINFECTION

After completion of the work Contractor shall flush clean the entire system with the city’s filtered water after connection has been made.

After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the
system is fully disinfected and usable. The Commissioning would not be considered complete without performing the Disinfection.

**PRE COMMISSIONING:**

Ensure that all pipes are free from debris and obstructions.

Check all valves and fire hydrant for effective opening and closing action. Defects should be rectified or valves replaced.

Ensure that all Connections to Branches has been made.

Ensure that mains have been connected to the respective pumps, underground and Overhead tanks.

Water supply should be available at main Underground tank.

All main line Valves should be closed.

**COMMISSIONING**

Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).

Fill Overhead tank to full.

Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.

Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.

Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.

The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

**RESPONSIBILITY**

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.
SECTION –V: TUBEWELL

GENERAL CONDITIONS AND SPECIFICATIONS FOR TUBEWELL

General Conditions

All work shall be done in a systematic manner in accordance with a programmer prepared in consultation with the Engineer-in-Charge. Rates quoted shall be for complete items and inclusive of all equipment, labor, scaffolding, tackles etc required to do a complete job.

Rates shall be inclusive of all taxes, e.g. Sales Tax, Octroi, Excise Duty etc.

Expected quantity of water required is in the order of 10,000 LPH on 10-12 hours continuous pumping, but lower flow will be acceptable if the strata yield is such.

No payment shall be made for the abandoned bores.

Water Supply & Power

Contractor shall make his own arrangement for water at site required for his work. He may obtain the water by boring a trial bore or by obtaining in water tankers at his own cost.

Contractor shall also make his own arrangements for power required for his work.

Site Clearance

The Contractor shall clear the site for any trees, growth, grass and rubbish to enable him to execute the work properly at his own cost.

On successful completion of the work the Contractor shall clear up the site of all his surplus material equipment and accessories and hand over the same to the Engineer-in-Charge.

Specifications

Type of Well

a) Tube well shall be bored by a reverse circulation rotary rig with 600 mm dia (24") blind and slotted pipe. Annular space between pipe and bore shall be gravel packed.

Boring

Boring shall be 600-650 mm dia to an approximate depth of 80-90 m. The depth may be increased or decreased as per actual site conditions. The depth at which the tube well boring is to be terminated shall be as agreed upon by the Engineer-in-Charge Sub-soil water shall not be tapped.

Well and Housing Pipes

Pipes shall be uPVC pressure pipe with couplings.
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

Slotted Pipes

Slotted pipes shall be 250 mm dia, with slots. Slot size shall be as per soil conditions and shall be approved by the Engineer-in-Charge. No variation in rate shall be permissible due to size and dimension of slots.

Special Fittings

Provide all special fittings e.g. blank pipes, socket rings, bail plug, centering guides, pipe slips and top cap suitable for housing pipe.

Verticality

Well assembly shall be truly vertical as per latest Indian Standard and verticality certificate shall be furnished by the Contractor.

Gravel Packing

Space between boring and well assembly shall be packed with washed pea gravel 3 to 6 mm size.

Development

The well shall be developed by an air compressor of 450 cfm capacity and pressure of 10.5 kg/cm² for a period of at least twenty hours. This period may however be extended in case the development is not satisfactory.

Water Tests

The Contractor shall get the water tested for its quality from approved Water Testing laboratory given Annexure I. Tests shall be for drinking water quality as per IS: 10500 for Physical, Chemical & bacteriological parameters. (Tests shall be performed after development of the well and clear water is available in the discharge).

Sanitary Sealing

The annular space between the bore and its housing pipe shall be grouted with cement concrete 1:2:4 to a depth of 5 m below the ground level. Four 50 mm dia gravel feeding shall be provided with caps at top. Pipes shall be G.I. to I.S. 1239, medium class.

Bore Log

A bore log in a standard format form shall be maintained at the site and shall give the following information.

a) Description and depth of strata
b) Spring level below ground.

c) Aquifer opposite which slotted pipes have been placed.

d) Rate of progress of drilling

e) Full particulars of final test

f) Four copies of strata sheets yield and water quality tests shall be handed over on completion of the well.

g) Suggested depth for the tube well submersible pump.

SECTION – VI: GARDEN HYDRANT SYSTEM

SCOPE OF WORK

The scope of this section comprise of the supply, installation testing and commissioning of piping network for garden hydrant & irrigation system.

Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the garden irrigation system as required by the drawings, specified hereinafter and given in the Drawing.

Without restricting to the generality of the foregoing, the garden hydrant system shall include the following:-

- All irrigation lines to different parts of site and making connection from source i.e. from STP etc.
- Pipe protection.
- Control valves, masonry chambers and other appurtenances.
- Connections to all hydrant point.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

As far as possible shall be installed at-least 60cms below finished grade.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.
FLANGES
Flanged connections shall be provided on pipes wherever required or as directed by Engineer-in-Charge. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer.

TRENCHES
The HDPE pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes 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>15mm to 50mm</td>
<td>30 cms</td>
<td>60 cms</td>
</tr>
<tr>
<td>65mm to 100mm</td>
<td>45 cms</td>
<td>75 cms</td>
</tr>
</tbody>
</table>

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

PIPE PROTECTION
Where specified in the Drawing all pipes below ground shall be in trenches and protected with fine sand 150 mm all around before filling in the trenches.

SECTION – VII : SEWERAGE/DRAINAGE SYSTEM

SCOPE OF WORK
Work under this section shall consist of furnishing all Labor, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as specified hereinafter or given in the Drawing.

Without restricting to the generality of the foregoing, the sewerage system shall include:

- Internal/External sewer line.
- Excavations including refilling etc.
- Construction of Collection Chambers, Manholes and Drop Connections.
• Construction of Grease Trap etc.
• Connection to S.T.P and Disposal of treated effluent.
• Storm Water Drainage and Disposal.
• Construction of Desalting chamber & Rain water Harvesting tank
• Testing of pipe lines

GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.

Drainage lines shall be laid to the required gradients and profiles.

All piping shall be installed at depth greater than 80cms below finished ground level.

The piping system shall be vented suitably at the starting point of all branch drains, main drains, and the highest/lowest point of drain and at intervals as shown. All venting arrangement shall be unobstructive and concealed.

All drainage work shall be done in accordance with the local Municipal bye-laws.

Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Engineer-in-Charge.

Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge before the actual execution of work at site.

All works shall be executed as directed by Engineer-in-Charge.

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 Engineer-in-Charge from time to time to meet the requirements of the works. 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 Engineer-in-Charge.

SALT GLAZED STONEWARE PIPES

Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside or outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to IS: 651-1971 and shall be of approved makes.

The maximum permissible slope to the various diameters of pipes shall be as follows:

100mm pipe …… 1 in 40 to 1:50
150mm pipe ...... 1 in 60 to 1:100
200mm pipe ...... 1 in 80 1: 120 to 1: 200
250mm pipe ...... 1 in 90 1: 120 to 1: 250

Where necessary, pipe shall be laid on a bed of plain cement concrete 1:3:6 and minimum 150 mm thick, and shall be projected by providing hunching up to half the diameter of the pipes. The width of the concrete bed for various diameters shall be as follows:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mm dia pipe</td>
<td>380mm wide</td>
</tr>
<tr>
<td>150mm dia pipe</td>
<td>450mm wide</td>
</tr>
<tr>
<td>200mm dia pipe</td>
<td>600mm wide</td>
</tr>
<tr>
<td>250mm dia pipe</td>
<td>700mm wide</td>
</tr>
</tbody>
</table>

Where the pipes are laid on a soft soil, with the maximum water table level, lying at the invert level of the pipe, the pipe shall be bedded in concrete.

**Laying and Jointing of Stoneware Salt Glazed Pipes**

**Laying of 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 rung 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 should be segregated, marked in a conspicuous manner and their use in the works prevented.

The pipes shall be laid with sockets leading uphill and should 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 pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete 1:5:10 mix at the Contractor’s cost and charges.

If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed of 1:5:10 mix to ensure even bearing.

**Jointing of 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 should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The 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 inside of the joint with a suitable scraper or “Badger”. The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all rounds the pipes for inspection by the Engineer-in-Charge. 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.

- **Gully Traps**
  Gully traps shall be of the same quality as described for stoneware pipes in Clause 5.

  Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40mm nominal size) and a brick masonry chamber 30x30 cms inside in cement mortar 1:3 with 10 x 10 cms grating inside and 30x30 cms C.I. sealed cover and frame weighting not less than 7.2 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

- **Grease Trap**

  Grease Trap shall be provided on Kitchen waste lines before discharging the waste into the main sewer line. Grease Trap shall be built in brick masonry and shall be similar in construction to manholes. The grease trap shall be constructed to size as shown at the location on drawings. The grease trap shall be provided with drop inlet, drop outlet, galvanized wrought iron sediment pan and a baffle wall. Grease trap shall be provided with 2 Nos, double seal manhole cover and frame which shall be identified with lettering "Grease trap" as per the drawing.

  - **Testing of Grease Trap**

    All rights of the sewer and drain shall be carefully tested for water tightness by mains of water pressure maintained for not less than 30 minutes. Testing shall be carried out for manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of Water. The test pressure will however, not exceed 6mtr head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

**REINFORCED CEMENT CONCRETE PIPES**

All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes of specified class. 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, when directed a certificate to that effect from the manufacturer.
Laying

R.C.C. spun pipes shall be laid on cement concrete bed or 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 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall than be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge.

Encasing (all pipes have to be encased)

The sewer pipes shall be completely encased or surrounded with concrete where:

- The maximum water table level is likely to rise above the top of the barrel.
- The top (overt) of pipe is less than 200 cms under the road surface.

Jointing

After setting out the pipes the collars shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools all joints shall be finished at an angle of 45 degree to the longitudinal axis of the pipe on both side of the collars neatly semi flexible type collar joint.

Curing

The joint shall be cured for at least 7 days. Refilling at joints will be permitted only on satisfactory completion of curing period.

CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.

Materials

Water

Water used for all the construction 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 well enough for construction purpose.

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 Engineer-in-Charge. The size of the coarse aggregate shall be done as per I S: 383.

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 strong, 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 Engineer-in-Charge as harmful for the construction.

Cement
The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I S: 269.

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).

Bricks
Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plan 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 Engineer-in-Charge.

Other Materials
Other materials not fully specified in these specifications and which may be required in the work shall conform to the I S code. All such materials shall be approved by the Engineer-in-Charge before use.

Cement Concrete (Plain or Reinforced)
Cement concrete pipes bedding, cradles, foundations and RCC 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 Engineer-in-Charge. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bass at all times. All pipe trenches and foundations shall be kept dry during the curing period.

Masonry Work
Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Drawing in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

Cement Concrete for Pipe Support
Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be given in the Drawing. Type of the bedding is as described as follows:

Unless otherwise directed by the Engineer-in-Charge cement concrete for bed, all round or in haunches shall be laid as follows:-
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
<thead>
<tr>
<th>Description</th>
<th>Up to 3 M depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes in open ground (No sub soil water)</td>
<td>All round (1:4:8)</td>
</tr>
<tr>
<td>Pipes (all) in sub soil water condition</td>
<td>All round (1:4:8)</td>
</tr>
<tr>
<td>Pipes under the building or at road crossing or under public places</td>
<td>All round (1:3:6)</td>
</tr>
</tbody>
</table>

(1=1 cement, 3-5=coarse sand, 6-10 stone aggregate 40mm nominal size)

R.C.C. pipes or C.I. pipes may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.

Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

MANHOLES AND CHAMBERS

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 Drawing.

All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix or shown on the drawings.

Where not specified, Manholes will be constructed as follows:-

(All dimensions internal clear in cms)

<table>
<thead>
<tr>
<th>Size of Manhole Type</th>
<th>90x80 Rect.</th>
<th>120x90 Rect.</th>
<th>910 dia Circular</th>
<th>1220 dia Circular</th>
<th>1520 dia Circular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum depth</td>
<td>100</td>
<td>245</td>
<td>170</td>
<td>230</td>
<td>Any depth beyond 230</td>
</tr>
<tr>
<td>Average thickness of R.C.C slab</td>
<td>15</td>
<td>15</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Size of cover and frame (Internal dia)</td>
<td>61x45.5</td>
<td>50 dia</td>
<td>56 dia</td>
<td>56 dia</td>
<td>56 dia</td>
</tr>
<tr>
<td>Weight of cover and frame</td>
<td>38 Kg.</td>
<td>116 Kg.</td>
<td>116 Kg.</td>
<td>116 Kg.</td>
<td>116 Kg.</td>
</tr>
<tr>
<td>Type of Cover &amp; Frame</td>
<td>SFRC</td>
<td>SFRC</td>
<td>SFRC</td>
<td>SFRC</td>
<td>SFRC</td>
</tr>
</tbody>
</table>

All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm 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.

All manholes shall be plastered with 12/15mm 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.
All manholes with depths greater than 1 M. shall be provided with plastic encapsulated 20mm square or 25mm round rods foot rungs set in cement concrete blocks 25 x 10 x 10cms in 1:2:4 mix 30cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab or SFRC precast concrete covers as per instructions of the Engineer-in-Charge. Weight of cover, frame and thickness of slab as given above.

All Rainwater Collection Chamber shall be of the size 50x45x60cm (internal) with horizontal C.I. grating or SFRC precast Gully Grating as per instructions of Engineer-in-Charge. The grating along with frame shall be of size 500x450mm grating having total Wt. of app. 38 Kg and of approved design and quality as per instruction of Engineer-in-Charge. The remaining details of construction shall be same as stated above for the construction of the Manholes etc.

MAKING CONNECTIONS

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

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.

DE-SALTING CHAMBER & RAIN WATER HARVESTING TANK

All Rainwater Collection Chamber shall be of the size 200x100x60cm (internal) complete as per drawing or as instructions of Engineer-in-Charge.

Rain water harvesting pit is constructed preferably 5 to 10m from the permanent structure. The bore will be excavated manually or drilled by reverse direct rotary method up to the water level or as per instruction of Engineer-in-Charge.

The dia of Rain water harvesting pit shall be 3000mm. Pit shall be filled with boulders, gravel and coarse sand.

Bore shall be 250mm dia and pipe shall be 160 OD uPVC 6 kg /cm². The pipe placed in the center of the shaft touching the lowest portion of the pit. The overflow pipe from the desalting chamber is directly connected to the rain water harvesting pit so that the rain water freely enters the pit for recharging. In addition to the inlet pipe from desalting chamber an overflow pipe at the ground level so that any excess water that enters the pit is automatically drained away without damaging the pit.
SECTION – VIII:  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.

<table>
<thead>
<tr>
<th>Packages/ Sanitary Fixtures</th>
<th>Soil, waste &amp; vent pipes</th>
<th>Water supply system</th>
<th>Sewerage/ drainage system</th>
<th>Water tanks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List of inventory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training Conducted on</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Manual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maint. Manual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As built P&amp;I Diag/ SLD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defects Liability Period/ Warranty</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning report</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test reports/ Certificates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List of essential spares</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address/ Contact nos. of Vendors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
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</tr>
</tbody>
</table>
SECTION – IX: HOT WATER GENERATORS

STEAM GENERATORS

Scope

The scope of this section comprises the supply, erection, testing and commissioning of steam generator & allied equipments conforming to these specifications and in accordance with requirements of the system.

a. The steam boiler is to be a fire tube fully automatic oil fired packaged boiler developed tested and proven under rigorous conditions and subject to the strictest quality control procedures.
b. The Boiler shall confirm to the IBR standard for design and manufacturing of shell type boilers. All components and processes used in the manufacture shall comply with the requirements of the Indian Boiler Regulations.
c. Ample furnace and combustion volume shall be provided to ensure complete combustion.
d. A large heating surface is to be provided in the radiant zone to allow effective heat transfer.
e. Heat flux is to be kept to a bare minimum by providing adequate total heating surface, to limit the scale formation on heat transfer area.
f. The Boiler shall have a three pass flue path. The first pass shall be the furnace, whereas nests of smoke tubes are to form the 2nd and 3rd passes. At the end of the furnace a wet back type combustion chambers are to be provided, to allow the reversal of the flue gas and direct it to second pass tubes.
g. The fire tubes in the tubes nest are to be plain without any restriction inside to reduce pressure drop and maintenance issues. The tubes are to be easily accessible both from inside as well as outside for inspection and maintenance. The required number of stay tubes and stay bars are to be fitted in the boiler.
h. A reversing chamber at the front of the boiler shall transfer the flue gases from the second pass to the third pass of the boiler. The flue gas outlet shall be positioned at the rear side of the boiler just after the third pass.
i. All working parts of the boiler are to be accessible for ease of inspection and maintenance. On the shell, adequate Man Access Doors are to be provided. Access to the combustion chamber is to be through a bolted refractory lined access door whereas tube nest is to be exposed through hinged mounted front door and bolted covers on back casing plate.
j. The Boiler shall be fitted with a Pressure Jet burner and the Burner shall be capable of firing furnace oil up to 3500 Red. Sec. 1 at 1000 F viscosities. The burners are to be fitted with FD fan, spark ignitors, oil heater, gear oil pump, flame surveillance system and damper motor assembly.
k. The control panel shall be a part and parcel of the boiler. It shall contain all switchgear, safety alarms/interlocks and burner management system. For water level control in the shell a magnetic level switch along with a separate override unit shall be provided to ensure positive level shut off fuel supply to burner under extra low water level and puts the boiler under lock-out till the fault is rectified.
l. The control panel of the boiler shall include burner management sequential controller with self-diagnostic features to help quickly locate faults in boiler operation.
m. All required fittings/mountings as described below are to be provided for safe and trouble-free operation of the Boiler.
n. The Boiler Shell shall be Factory Insulated and the insulated cylindrical shell of the boiler is to be a heavy gauge sheet metal covered frame, which not only provides neat appearance but also protects insulation material properties.
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

a. **Pressure Parts**:  
• Boiler Shell  
• Tube Plates  
• Furnace Flue  
• Combustion Chamber  
• Boiler Tubes  
• Stays (Tubes, Bars, Gussets)  
• Access door on tube plate  
• Man Access door  
• Stand Pipes for Stop, Feed check, Safety and Blow down Valves  
• Stand pipes for gauge glass and level controller

b. **General Construction Parts**:  
• Front casing with hinged door  
• Rear casing with removable doors  
• Flue outlet flange  
• Insulation and sheeting for boiler shell  
• Rear access door refractory  
• Support base frame

c. **Mountings**:  
• Safety Valves (2 nos)  
• Main Stop Valve (1 no)  
• Feed check Stop Valve (2 nos)  
• Feed check NRV (2 nos)  
• Blow down Valve (1 no)  
• Water Gauge Glass (1 set)  
• Water level controls (2 sets)  
• Pressure gauge (1 no)  
• Inspector’s test connection (1 no)

d. **Combustion Equipment**:  
Fully automatic pressure jet design burner fitted with F. D. Fan, air / fuel ratio adjusting damper, pressure and temperature gauges, thermostat, Spark Ignitor and flame surveillance sensor.

e. **Feed Pumps**:  
2 nos. electrically driven centrifugal multistage pump with motor, interconnected pipe work between pumps and feed check valves.

f. **Instruments and Control**:  
• Blow down valve  
• Main steam pressure gauge with cock.  
• Level controller for feed pump operation and low water level alarm.  
• Over-ride controller for lockout under extra low water level alarm.  
• Pressure control switches.  
• Flame surveillance and burner management controller.  
• All switch gears, relay, connectors.  
• Audio / visual alarm in case of unsafe operation for lockout under extreme conditions.
• Pressure and temp gauge with thermostat for burner.
• Control panel housing above instruments and switch gears.

g. **General Items**
• Operation and maintenance instructions.
• Feed water piping between feed check valve and pump outlet.
• Pressure gauge tubing.

**Fuel Oil Piping**

**Scope**
The scope of this section comprises the supply and laying of pipes, pipe fittings and valves testing and balancing of all HSD piping required for the complete installation as shown on the drawings. All piping inclusive of fittings and valves shall follow the applicable BIS Codes. The HSD Bulk Fuel Storage Tank is supplied by others. Contractor shall arrange to take a tap off from the HSD transfer pump discharge for his service (Day oil) Tanks. The tap off shall be provided by level sources in the Day oil Tank.

Overflow from the Day oil Tanks shall be led to energy overflow Tank altered to a pump to transfer the overflowed HSD back to the Buck fuel Tank.

The overflow Tank shall be provided with an automatic pump start/stop level controller which will also be capable of providing an audio visual alarm indicating overflow.

All Electrical components used shall be rated for HSD duty and flow proof.

a. Pipes shall be MS class ‘C’ & 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 metal arc welding of mild steel.

b. All pipes and their steel supports shall be thoroughly cleaned and given on 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 40 mm</td>
<td>Gun Metal</td>
<td>Screwed</td>
</tr>
<tr>
<td>50 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 fiber / 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 40 mm</td>
<td>Gun Metal</td>
<td>Screwed</td>
</tr>
<tr>
<td>50 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 miles 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.

**Steam Generator Performance Test**

Following listed tests shall be conducted after installation of the boiler:

a) Capacity test to confirm 600 Kg/Hr from @ 10.5 kg/sqm and at 100 deg. C
b) Dryness fraction test to confirm 0.95 dryness at full load.
c) All controls and safety test.
d) Efficiency test to confirm maximum 88% on N.C.V. (at specified fuel consumption)
e) Safety valve blow test.
f) Hydraulic test.

Steam Generator Inspection

Contractor shall arrange the inspection and dry trial at works of the Steam Generator prior to dispatch if so required by the Owners.

Drawings
Contractor shall furnish following drawings in triplicate within two weeks from the date of order to the consultants.

a) Foundation details of each Steam Generator.
b) Steam Generator electrical wiring diagram.
c) Steam Generator operation manual.
d) P & I diagram.
e) General arrangement & Terminal point details.
f) Proposed Layout Of Boiler House.

Warranty

Contractor shall furnish a guaranty of 12 months from the date of commissioning and testing against faulty design, materials or workmanship. During guaranty period supplier is bound to replace the defective parts free of cost.

Precommissioning

On completion of the entire erection of equipment, piping, connection to the pipe system and electrical system, contractor shall fill the entire system with cold water and test for leakage and other erection defects. All such defects shall be removed. All motors shall be test started.

Commissioning & Testing

On completion of all procedures at pre-commissioning stage, Steam Generator shall be fired by the respective supplier, and all adjustments shall be carried out in valves and other accessories for all related equipments. Steam Generator shall be allowed to run till the desired pressure & temperature in the system is obtained. Any defects noted shall be rectified immediately.

Installation Instructions

On completion of installation, commissioning and testing, contractor shall provide services of their technical staff to train the Owner’s staff in operating day to day maintenance of the installation for a period of 15 working days.

a) Contractor shall provide six sets of completion drawings showing “As-installed location of all heat exchangers, equipment piping and valves. One copy of the drawing shall be mounted on a glass frame and fixed in Steam Generator room.
b) Contractor shall provide six sets of erection and maintenance manual of all equipment supplied and erected by him. The manual shall include information regarding model No., Year and manufacturer and
The manuals shall be bound in stiff covers. Necessary IBR certificates /Inspection report all registry books.

c) Contractor shall perform such tests that may be necessary and required and as directed by Project Engineer to test the rated capacity of the equipment.

d) The Contractor shall advise owners operators regarding feed water treatment and give the requirement of chemicals and dosing schedule for smooth and trouble free operation of the system.

The Contractor shall make arrangements to have the Boilers and its Installation completed and approved by the Boilers Inspector. The Installation shall be handed over as a complete ready to operate and approved installation.

The steam and condensate recovery system shall be designed by

**Technical Information**

The contractor shall fill in the following technical data:

**DESCRIPTION**

**STEAM GENERATOR**

**Steam Generator**

Rated output in Kgs/Hr : 

a) Overload factor : 

b) Make : 

c) Overall dimensions : 

d) Dead Weight (Empty) : 

e) Dead Weight (Operational) : 

f) Volumetric Capacity of shell : 

**Type of Steam Generator**

a) Designed working pressure : 

b) Total heating surface : 

c) Heat exchange ratio : 

d) Fuel consumption per hour (HSD) : 

**Efficiency**

a) Overall (ON NCV) : 

b) Dia of smoke outlet. : 

c) Temp. of gases leaving stack at full load : 

d) Size of combined flue. : 

e) Static pressure at stack. : 

f) CO2 at outlet of Boiler : 

Details (Size, Make of the Boiler Mountings Offered)

<table>
<thead>
<tr>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Inlet valve for feed water</td>
<td>:</td>
</tr>
<tr>
<td>b) Outlet valve on top for primary Flow (main steam stop valve)</td>
<td>:</td>
</tr>
<tr>
<td>c) Auxiliary outlet valve &amp; blow Down valve</td>
<td>:</td>
</tr>
<tr>
<td>d) Horizontal check valve</td>
<td>:</td>
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<tr>
<td>e) Safety Valve</td>
<td>:</td>
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<tr>
<td>f) Any other accessory offered.</td>
<td>:</td>
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</tbody>
</table>

Oil Firing Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Make</td>
<td>:</td>
</tr>
<tr>
<td>b) Model No.</td>
<td>:</td>
</tr>
</tbody>
</table>

Flue Gas Details

Capacity of Firing

<table>
<thead>
<tr>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Type and size/HP of air blower</td>
<td>:</td>
</tr>
<tr>
<td>b) Capacity of blower</td>
<td>:</td>
</tr>
<tr>
<td>c) Size of oil inlet line</td>
<td>:</td>
</tr>
<tr>
<td>d) Size of oil return line</td>
<td>:</td>
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</tbody>
</table>

Boiler Feed Tank

<table>
<thead>
<tr>
<th>Description</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>a) Size</td>
<td>:</td>
</tr>
<tr>
<td>b) Thickness of sheet</td>
<td>:</td>
</tr>
<tr>
<td>c) Capacity</td>
<td>:</td>
</tr>
</tbody>
</table>

Piping For Steam Generators

Piping

All Boiler pipes and accessories will the pressure is reduced to 1kg/cm², shall be IBR and approved by the Boiler Inspector. The entire installation shall be approved by the Boiler Inspector.

All steam pipes shall be M.S. heavy class pipes conforming to IS: 1239 part I with heavy class pipe fittings. All fittings shall be weldable type. The pipes shall be properly ground at the ends to make a vee. The two pipes before being welded shall be placed on the vee block, properly aligned. A gap of 2-3 mm shall be maintained between the two pipes and V butt welding done. All welding flux material of the root run shall be removed using metal brushes. The final welding shall be done over the root run forming a proper bead of the welding.

Flanges

All M.S. flanges shall be raised face, slip on type conforming to class ASA 300 and shall be of welded neck type.
Gaskets
The gaskets shall be made out of the fire retardant material. The gasket material shall preferably be minimum 3 mm thick compressed asbestos capable of withstanding minimum 600 degree centigrade temperature.

Nuts, Bolts & Washers
All nuts & bolts shall be of high tensile M.S. The length of the bolts shall be such that about half an inch of bolt shall protrude outside the face of nuts. In all nut & bolt joints, washers of suitable sizes shall be used on the bolts as well as nuts side.

Valves
All valves used for steam piping shall be globe valves of class 150. All valves shall be of cast steel or forged steel with gun metal or SS trimmings. Globe valves shall conform to API 602/600.

Steam Traps
The steam traps shall be either thermodynamic or inverted bucket/Float type & depending upon the application and for draining the condensate from the main stream line or branch line. Steam traps shall also be provided with strainer and bypass arrangement. The body of inverted bucket steam trap shall be of cast steel. The body material for thermodynamic steam traps shall be of stainless steel.

Safety Valves
Safety valves shall be of high lift type with casing lever, for manual flow. The material shall be of bronze/cast steel.

Pipe Line Supports & Pipe Layouts
Pipe line supports shall be installed in a manner so that the pipe line is free to move as a result of expansion or contraction. Steam lines should be arranged with a fall in the direction of flow. A fall of around 40 mm in 10 M shall generally be provided. Drain points shall be provided at every 30 to 50 M interval. Drain points shall also be provided at any low points where condensate can collect. Branch connections should always be taken from the top of any main. Drain points shall preferably be provided wherever pipe work changes direction, when drainage has to be provided in a straight length of pipe then a large bore pocket should be provided. Concentric reducers shall be avoided and eccentric reducers shall be used.

Allowance for Expansion
Wherever there are long runs of straight pipe some provision for expansion must be kept. Horse shoe or lyre loop/sliding joints must be used to take care of expansion.

Steam Piping Insulation
Steam piping insulation shall consist of following:

a) Application of heat resistant paint.

b) Application of preformed pipe section of glass wool of thickness as specified in the schedule of quantities and having density not less than 80 Kg/Cubic M.

c) Covering the insulation with chicken mesh & hessian cloth.
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d) Covering the insulation with 24 gauge ribbed aluminum sheet cladding and fixing in position with a self tapping screws at 150 mm centre. All joints shall be overlapped by 50 mm and arranged to shed water.

DAY OIL TANK

Type

The capacity of fuel tank is actual useful capacity viz the storage between the drain level and overflow level, with zero level marking on the gauge starting from drain level.

Construction

a) The tank shall be fabricated from min 4mm thick MS sheet.
b) The fuel tank top shall be fully bolted type and shall have a bolted type inspection manhole cover with a handle, so that ordinary inspection and minor cleaning of tank can be carried out.
c) The top cover & inspection cover fitting shall be so as to make it water proof, fitted with min 5mm thick neoprene rubber gasket.
d) In case of floor mounted tanks the tank shall have fabricated footing on four corners so that the bottom of fuel tank is atleast 150mm above resting level or floor level, to enable cleaning of space below, drain the tank etc.
e) In case of structure mounted high level day tank, instead of footings an appropriate channel base shall be provided.
e) Fire safety requirement to be integrated for the Day oil Tank.

Fitments

a) The tank shall have appropriate fitments as mentioned below
   i. Filling connection
   ii. Fuel feed connection.
   iii. Fuel returns connection.
   iv. Air vent
   v. Drain valve with plug & sampling nozzle.
   vi. Overflow Pipe.
   vii. Fuel level gauge.
   viii. Low fuel level alarm.

b) The drain valve shall be of min 25mm dia, industrial type only. Audco valve or similar construction and quality only is to be provided to provide reliable, drip proof system. Commercial quality gun metal or brass valves are not acceptable.

   The drain valve shall be located preferably at the bottom most level in front at either corner so that complete & thorough draining for cleaning purposes is possible.

   To give a proper slope, about 10mm thick flat plates shall be welded so that when the tank is placed on that floor a gentle slope towards the drain cock is available.
The actual location of drain cock & fuel level gauge should be such that a drip tray could always be placed below these fitments to prevent diesel spilling accidentally or during maintenance operation.

c) The fuel level gauge glass shall consist of two right angle nozzles, to which good quality transparent heavy gauge alkathene/PVC pipe (flexible type) could be tightly inserted. The pipe so fitted shall be in perfect vertical alignment. Shut off cocks should be provided at the top & bottom. The pipe should be protected in a SS tube with a cut to allow.

A calibrated, 3mm thick aluminium scale shall be screw fitted behind the pipe so that the level in mm & liters can be readily read. The scale markings shall be engraved type with red paint filled, readable against white background.

After the construction of tank, the quantity in liters shall be established on the scale by filling water in measured quantities i.e. actual calibration shall be done.

d) The fuel feed connection shall have fine mesh screen filter or diesel filter, micro porcelain type for HSD day oil tanks & duplex filter of 100 micron filtration for boilers feed day oil tanks so that only clean filtered diesel goes in the fuel feed pipe going to the equipment. The screen mesh filter/duplex filter should be easily accessed for cleaning and external fitment of these is preferred.

The fuel feed pipe shall be so provided that this feed is only at 150mm above the bottom, to prevent water and settled impurities getting into fuel feed pipe system.

e) In case of high level tank system MS supporting structure welded type of adequate height, rung ladder with hand rails, & platform with chequered plates shall be supplied to form a complete system. The erection of these structures etc., forms the scope of work of vendor. About 0.75M space around the tank atleast on 3 sides at the level of tank should be present for ease of operation & maintenance.

Further the drain of tank shall be brought down to an approximate level of 1M above G.L. by well laid out piping system with drain valve & cock provided at this level.

**Painting**

The day tanks, after fabrication & calibration shall be thoroughly cleaned & spray painted with two base coats plus two finish coats of special diesel resistant paint.

The supporting structure also should be cleaned & painted with two coats of base primer and two coats of enamel paint.
SECTION – X: SEWAGE TREATMENT PLANT (STP)

SCOPE

Work under this Contract consists of

- Detailed engineering design of all plan areas, section, Civil, Structural, mechanical, electrical and piping systems according to the current and applicable BIS codes as applicable. The proposed plans of the STP shall be subject to the approval of the Architect / Consultant.

- Design, manufacture, assembly, installation, testing and commissioning of the main treatment units in RCC tanks, mechanical equipment for the packaged type Sewage Treatment Plant (STP) of capacity and design parameters given in BOQ & specifications broadly comprising of:
  - Diffused aeration system comprising of non-metallic piping submerged diffusers to be provided in the RCC equalization tank, **MBBR unit**, and sludge holding tank
  - Twin lobe air blowers with belt drive, electrical motors, piping headers, piping connections to all units.
  - Pumping sets from equalization tank to STP, effluent, post filtration and final effluent disposal pumps as per design requirements.
  - Final effluent pressure filters, softener pumps for final disposal/reuse.
  - Motor control centers, cabling from MCC to all units, all instrumentation, and measuring devices and earthing of equipment. All electrical works to be carried out guidelines as per detailed annexure enclosed.
  - Instrumentation and chemical test kit as specified.

- Drain channel, sump with a drainage submersible pump (1 working + 1 standby) with pipe work, valves and discharge pipe up to nearest external manhole in plant room shall be provided by others.

- Provide PH Meter, Electronic magnetic flow meter in inlet & outlet of filtration system

The Work Includes

- Civil, Mechanical & Electrical works
- Piping as specified.
- Testing, commissioning and operation of plant with water and under load conditions.

Construction of all architectural, civil and structural works related to the construction of the building, its internal lighting, sludge disposal system.

Incoming power connection, electrification of pump house.

Incoming sewer / rising main connection to the plant.

Connection from final effluent tank / pump to point of use for reuse or for disposal in accordance with approval of the State Board for Prevention and Control of Pollution.
Shop Drawings

The contractor shall submit shop drawings as follows:

- On award of the work, he shall submit GA drawing, PIB diagrams, plant layout with basic dimensions, flow diagram with levels of elements.
- Fabrication and equipment layout piping, valves and all other information required for installation.
- Electrical layouts, detail of all MCC, cable sizing and system diagrams and earthing system.
- Piping layout with pipe dia. slopes, fixing arrangements.
- Three copies of the shop drawings shall be submitted for initial scrutiny. On approval of the same contractor shall submit six copies of the same incorporating corrections etc. Two sets will be stamped “GOOD FOR CONSTRUCTION” by the Consultant and returned to the contractor.

Other Submittals

Contractor shall furnish four sets of folders giving:

- Catalogues and technical information sheets of equipment to be installed.
- Performance curves, foundation details and fixing arrangements.

Contractors proposal for testing procedures for individual equipment and for overall testing of the plant.

Submittals shall be separate for:

- Mechanical and Piping works
- Electrical Works

All shop drawings and submittals mentioned above shall be approved by Architect and two sets duly stamped shall be returned to the contractor for execution of the works.

Execution of Work

All work shall be executed only in accordance with the approved shop drawings and other submittals. Contractor shall ensure that all inserts, support plates, puddle flanges and other items required to be incorporated during execution shall be placed in position as per his own requirements during execution of the works.

All special tools and tackle required for erection and assembly of the equipment covered by the contract shall be obtained by the contractor himself. All other materials such as foundation bolt nuts, etc. required for the installation of the plant and equipment shall be supplied by the contractor and are part of the contract.

Testing & Handing Over

The contractor shall carryout tests on different equipment as required in the presence of the Consultant or his representative in order to enable him to determine whether the plant, equipment and installation comply with the specifications, local codes and in accordance with the letter and intents of the specifications.
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The installation shall be handed over to the Engineer-in-Charge only on successful completion, operational tests and acceptance of the effluent quality by the municipal / pollution control and statutory authorities.

Statutory Permissions

Contractor shall submit a write-up of process of the plant, drawings, design parameters flow and PIB diagrams as necessary and required for submission to the State pollution control authority.

Contractor shall furnish at his own cost, analysis of influent at source (for evaluation) as well as that of influent at the holding tank of the STP and the effluents from the STP for submitting to State Pollution Control Board and any other statutory authority whose approval is required.

Contractor shall perform all testing and operation of the plant in presence of the Pollution Control Board if so stipulated by them.

Contractor to obtain all statutory approval as required for PCB or any other approval. Only official fee will be reimbursed to contractor by the Owner.

Completion Documents

On successful completion of the entire work, the contractor shall submit 4 sets of following documents to Architect.

A brief write-up of process, day to day operating and maintenance instructions.

List of approved chemicals and procedure for storage and safety norms.

Completion drawing and data, catalogues, performance charts, technical data sheets and equipments installed.

Manufacturer’s maintenance and operating instructions for mechanical and electrical equipment.

Laminated and framed “As Built” drawings with plans, section, process flow diagrams, pipe runs, levels and final disposal point schedule of equipment installed with all their model Nos. plate data and date of installation.

Test readings of Influent & Effluent parameters taken at final handing over time

NOC (No Objection Certificate) from State Pollution Control Board and any other statutory authority whose approval is required.

Performance Guarantee

Equipment supplied and installed shall be guaranteed to yield the specified effluent standards which must meet and accepted with the requirements of Pollution Control Board.

The guarantee implicitly includes replacement of the entire plant on failure to meet desired effluent parameters, replacement of individual equipment or repairs as warranted. Decision on each and every aspect on this matter shall rest with the Consultant and shall be final and binding on the contractor.
Defects Liability

All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period of 12 months reckoned after taking over of system by Owner along with the documentation. During the defects liability period, the contractor shall replace defective parts and components free of cost. Rectification or repair may be permitted in case the defect is of minor nature.

Deviations from Tender Specifications

Tendered may indicate their comments only as deviations from the conditions stipulated herein. Wholesale submission of their own conditions and/or printed conditions in disregard of the conditions stipulated herein shall not be binding on this Tender.

No corrections, erasure etc. of this document shall be accepted.

Sewage Characteristics

Design Parameters

- **Project**: Hospital Building
- **Usage**: Office workers / Patient
- **Location**: Under ground
- **Level**: Ground

Design Consideration

- **Capacity (Max)**: 500m3/day
- **Area Available**: 350 Sqm
- **Operation**: Domestic Sewage (round the clock)
- **Influent**
  - pH: 7.5 to 8.5
  - BOD 5 days @ 200C.: upto 250-350 mg/l
  - Suspended solids (SS): upto 250-400 mg/l
  - Oil & grease: 50 mg/l
  - COD: upto 450-600 mg/l

- **Treated Effluent**
  - pH: 6 - 7
  - BOD 5 days @ 200C.: less than 20 mg/l
  - Suspended solids (SS): less than 10 mg/l
  - Oil & grease: NIL
  - COD: less than 100 mg/l
Salient Features
The plant should be suitable for low/peak flow in line with medical waste usage.

The plant should not create any noise, with no nuisance on fly or mosquito and no foul odors.

The plant should work without the use of in-organic chemical additives

The plant should be provided with tertiary treatment in form of duel media/activated carbon filter /UV system to provide zero bacteriological standards for reuse on:

- Irrigation system
- HVAC cooling tower

Basis of Design
The capacity/ rating of pumps and equipment etc. shall hold good for the capacity of 500 m3/day and shall be good for meeting the treated parameters requirement as follows:

- Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically Engineered organizations or Cell Rules, 1989.
- Manual on sewage & sewage treatment - CPHEEO
- All standards as laid down by Central Pollution Control Board and any other relevant statutory authority.
- 100% recycle of waste water and removal of sludge in cake from, no water to be discharged outside the premises.

Sewage Treatment Plant

General

The sewage treatment plant (STP) system outlined in this section specifies the system design, manufacture, supply and installation of a standard MBBR (Moving Bed Biofilm Reactor).

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 Consultant.

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 system/ cooling tower for HVAC/D.G etc.

Description of Process
The treatment process shall comprise the following stages:

- Physical treatment: Fine bar-screening / Oil & Grease Chamber
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- Equalization / Collection tank: Flow equalization with air mixing
- Biological treatment: MBBR based
- Final sedimentation: Settler tank
- Intermediate treatment: UV System in Intermediate tank
- Water reclamation: tertiary filtration and sterilization (For irrigation purpose, flushing or cooling tower make up)
- Sludge disposal: In cake form through Filter Press or (Transfer through a screwed type pump to municipal tanker)

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.

The treatment plant shall be designed to treat the above basic characteristics expected in the raw sewage.

Treated effluent shall be connected to a tertiary filtration / Softening plant to treat and shall be use for irrigation purpose and Flushing/CT make up purposes.

Process Description

- Inlet Screen Chamber / Oil & Grease Chamber

Raw sewage shall flow into the inlet screen chamber by gravity. Large solids particles shall be intercepted by a fine screen. Then there shall be Oil & Grease Tank. Sewerage will then flow into Equalization / Collection Tank The incoming sewage shall be mixed in the EQT and fine bubble aeration shall be maintained.

- Equalization / Collection Tank

The equalization tank shall be designed to provide a minimum storage of 2 hours at peak flow while pumping. Submersible pumps as per specifications shall be provided with level switch control and automatic cut-in of the standby unit.

An aeration system similar to the SAF tank shall be provided for mixing and aerating the sewage.

- MBBR Tank

Sewage shall be retained in the MBBR tank for a minimum of 4-5 hours and subjected to biochemical oxidation by fine bubbles aeration. The deck media shall be installed in the form of rectangular blocks & shall be fixed in the form of layers not more than 600 mm vertical height. The media shall be corrugated type & shall facilitate cross flow for better air distribution. The media shall be duly glued as per manufacturer’s recommendations.

- Tube Settler Tank

The sewage after bio-oxidation shall enter the hopper bottom sedimentation tank where the sludge effectively settles to the tank bottom. The clear effluent shall weir into the Intermediate Tank for UV treatment.
The activated sludge collected in the sludge tank shall be returned to the SAFF tank for further oxidation of the incoming organic matter. Excessive sludge shall be wasted in the sludge holding tank.

PVC tube deck media is to be installed in Tube Settler Tank. The media shall install at 600 angles with the horizontal and the total vertical height when installed should be 750 mm. The media shall be duly glued using recommended material and shall be installed as per the drawing to be given by the vendor as per manufacturer’s recommendation.

- **Intermediate Tank**
  The effluent shall be retained in the baffle walled cleared water tank for a minimum of 30 minutes for effective disinfection prior to discharge through UV system.

- **Sludge Holding Tank**
  Excessive sludge shall be stored in the sludge holding tank for final dewatering and disposal.

- **Then will be Treated Water Tank (TWT)**

- **Also there will be Soft Water Tank (SWT).**

**Equipment**

The following give the minimum requirements of the different components of the system.

All equipment and components of the system shall be of top quality construction and shall be corrosion resistant.

- **Fine Screening Equipment**
  Bar screen shall be of 304 stainless steel constructions. 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.

- **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 rpm.

  The size and performance of the air blower shall be so selected that it can provide a minimum airflow rate 0.5 l/sec / diffuser to 1l/sec/diffuser maximum, and to maintain a minimum of 2.0mg/dissolved oxygen in the aeration tanks in operation.

- **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.

- **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.

- **Settling Tanks**
  Settling tanks shall include baffles to prevent short circuiting.

- **Ultra Violet (UV) System**
  UV system shall be furnished as a complete package assembly for installation in the plant room. Assembly shall include UV Lamps suitable no. UV dosing system shall perform to achieve a residue not more than 1 mg/l in the treated effluent. feed pump shall have a maximum capacity of 1 l/hr will operate on 50 Hz supply.

- **Tertiary Treatment**
  This tertiary treatment shall be provided for the effluent used for irrigation and cooling tower make-up water tank/flushing system.

  The tertiary treatment plant shall comprise of the pressure sand filters and activated carbon filters. 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.

- **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 equipment.

- **Other Equipment**
  Any other necessary accessories, such as buffer, riser, scrub 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.

- **Piping Materials**
  
  - SS304 : Submerged air piping
  - MS epoxy : Air piping and pumped effluent riser (Non submerged)
  - PVC piping : Pumped effluent (submerged) & tank overflow pipe line.

**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 (rustles) shall be provided to indicate the open / close status as well as the use of each valve in the pump and tank rooms.

**PIPE SUPPORTS**

**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.

**INSTALLATION**

The Contractor shall check the associated civil work prior to the installation of any item of machinery and advise the Consultant, 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 leveled 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 Consultant for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

**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.
ELECTRICAL INSTALLATION

MOTOR CONTROL CENTRES

Switchboard cubicles of approval type shall be fabricated from 2mm thick CRC sheet with dust and vermin proof construction. It shall be painted with powder coating of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall compromise of the following (Switchgear as given in the schedule of quantities):

- Incoming MCCB of required capacity.
- MCCB / MPCB – one for each motor.
- Fully automatic DOL/Star Delta starters suitable for motor DOL upto 7.5 H.P.; Star / Delta for 10 H.P. and above H.P. with push buttons one for each motor and On / Off indicating neon lamps.
- Single phasing preventer of appropriate rating for each motor.
- Rotary duty selector switch
- Panel type ampere meters one for each motor shall be with rotary selector switch to read line currents.
- Panel type voltmeter on Incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.
- Neon phase indicating lamps and indicating lamp for each motor and on incoming mains.
- Rotary switch for manual or auto operation for each pump.
- Fully taped separate aluminum bus bar of required capacity for normal and emergency supply where specified.
- Space for liquid level controllers and other equipment specified separately in the contract / given in the schedule of quantities.
- The panel shall be pre-wired with color-coded wiring. All interconnecting wiring from incoming main to switchgear, meters and accessories within the switchboard panel. Wiring shall have suitable copper or aluminum ferrules.

Switchboard cubicle shall be floor or wall mounted type as directed by the Engineer-in-Charge.

SECTION – XI : REVERSE OSMOSIS SYSTEM FOR DIALYSIS

SCOPE & EXTENT OF WORK

Scope of Work

Work under this contract shall consist of furnishing all labor, materials, equipment and appliances necessary and required to supply, install, commission and operate a Localized RO with water cooler, as per BOQ.

RO Inlet water quality

Design and system manufacturing /assembling is entirely based on the following feed water analysis, assumed for design purpose. Please
### Parameter | Raw water
--- | ---
Colour | Absent
Total Suspended Solids | ≤ 2 mg/l
Turbidity | ≤ 2 NTU
pH | 6-8
Total hardness | ≤ 500 mg/l
Alkalinity | ≤ 47 mg/l
Fluoride | ≤ 1 mg/l
Silica | ≤ 10 mg/l
Iron & Heavy Metals | ≤ 1 mg/l
Total Dissolved Solids | ≤ 1000 mg/l

### Schedule and Technical Details of Reverse Osmosis System Micron Filter

**Purpose**

To remove the fine sand particle up to 0.05 micron and reduce silt density index to acceptable level.

**Specifications**

- **Cartridge filter & Housing**
  
  MOC of housing : PP  
  Length : 20”  
  Diameter : 6”  
  Quantity : 1No.

- **Cartridge:**
  
  Cartridge MOC : Polypropylene  
  Length : 20”  
  Diameter : 4”  
  Quantity : 1 No  
  Micron rating : 05micron
Dosing System

Purpose
To dose antiscalant chemical to protect the scaling formation on RO membranes.

Specifications:
- Chemical Tank Volume: l/hr 100
- Max. Frequency Stroke per Min.: 100
- Max. Back Pressure: l/h 1.08
- Max. Back Pressure: @ Bar 12.0
- Nominal Back Pressure: l/h 1.38
- Nominal Back Pressure: @ Bar 6.0
- O.D. x I.D.: mm 6 x 4
- Nominal Power: Watts 11
- MOC: PP
- Capacity: 0-6 lph
- Qty: 1No

High Pressure Pump

Purpose
To feed the reserve Osmosis Membrane at pressure more than the osmotic pressure Taking consideration flux rate, flow & recovery.

Specifications
- MOC: STAINLESS STEEL
- TYPE: VERTICAL MULTISTAGE
- FLOW RATE: 5000 LITERS PER HOUR.
- HEAD: 150
- POWER REQUIRED: 1.2.KW
- ELECTRICAL: 220VSINGLE, 50 HZ
- CYCLE: 2900RPM

RO Membrane

Purpose
To remove the major part of TDS up to 98% by Reverse Osmosis Membranes arranged & designed to give adequate flow & recovery
### Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Spiral Wounded</td>
</tr>
<tr>
<td>Diameter of Membrane</td>
<td>8.0 inch</td>
</tr>
<tr>
<td>Length of Membrane</td>
<td>1MT</td>
</tr>
<tr>
<td>No of Membranes</td>
<td>4</td>
</tr>
<tr>
<td>Recovery per Membrane</td>
<td>10-15 %</td>
</tr>
<tr>
<td>Salt Rejection per Membrane</td>
<td>98-99 %</td>
</tr>
<tr>
<td>Systems Recovery</td>
<td>60%</td>
</tr>
</tbody>
</table>

### RO Pressure Tube

**Purpose**
To pack Reverse Osmosis Membranes & operate at High pressure unto 250psi

**Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOC</td>
<td>SS/ FRP Composite</td>
</tr>
<tr>
<td>Diameter of Pressure vessel</td>
<td>8.5 inch</td>
</tr>
<tr>
<td>Length of pressure vessel</td>
<td>2.5miter</td>
</tr>
<tr>
<td>No Pressure Vessels</td>
<td>2</td>
</tr>
<tr>
<td>No of Membrane per Vessel</td>
<td>2</td>
</tr>
<tr>
<td>Position</td>
<td>Horizontal, Series</td>
</tr>
</tbody>
</table>

### RO Cleaning System

**Purpose**
We provide a flashing system, which shall help to clean the Membrane & get deposited on the membranes.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flushing Time</td>
<td>15 Minutes</td>
</tr>
<tr>
<td>Flushing Media</td>
<td>Treated water/Chemical</td>
</tr>
<tr>
<td>Flushing Tank Size</td>
<td>100 litre</td>
</tr>
<tr>
<td>Tank MOC</td>
<td>HDPE</td>
</tr>
<tr>
<td>Flushing Pump</td>
<td>Raw water pump will used</td>
</tr>
</tbody>
</table>

Semi automatic with two ball valves operation.

### Electrical Panel

**Purpose**
A control is provided as a safety measure for the Pump & other electrical items.
Specification

- Complete Starters Overload relays & single phase Preventer for pump.
- Voltmeter, Ammeter, MCB’s indicating lights.
- Push buttons. Rocker Switches for Dozers

Instrumentation

**Purpose**

- **Flow Meter**: To measure the online flow of water
- **TDS Meter**: To measure the online TDS of water
- **Low pressure Switch**: To protect Ro pump from dry running.
- **High Pressure Switch**: To protect RO pump from back pressure.
- **Pressure Gauges**: For calculate the pressure for each unit in RO system.
- **Rota Meter**: Quantity: 2 Nos.(permeate & reject line)
  Range: 2.4cum per hour

Digital TDS Meter

- **Quantity**: 1 No (Off line)
- **Range**: 10,000 ppm

Pressure Switch

- **Quantity**: 2 No (Low & high)
- **Range**: 0-450psi

Pressure Gauges

- **Quantity**: 6 No
- **Range**: 0-7 Bar.
- **Dial Size**: 2 inches
- **Type**: Bourdon

Plumbing & Fittings

Valves, pipelines before Ro module is in upvc (16 bar tested) & CPVC after HPP, till the permeate line termination point.

NRV’S pressure relief valves, wherever needed the system will be on common MS base frame.
SECTION – XII: 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 M.S. black steel (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.
• Hose Reels, Rubberized fabric lined hose pipes, Hose cabinets, Sprinkler heads and Landing Valves.
• Portable Fire Extinguishers
• Fire Fighting Pumps, diesel operated pumps, panels and all connected accessories including suction & delivery pipes.
• Testing Commissioning and giving live demonstrations to the various Inspection Authorities and Obtain their “No Objection Certificate” (NOC) for occupation of the building.

GENERAL REQUIREMENTS

All materials shall be of the best quality conforming to the Specifications and subject to the approval of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workman like manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in shaft, passage etc.

Pipes shall be securely fixed to walls and by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC s.

Valves and other appurtenance shall be so located that they are easily accessible for operation, repairs and maintenance.

PIPES

All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. Pipes as follows:

• Pipes 150 mm dia and below IS: 1239 (Class C) Heavy Class
• Pipe 200 mm dia and above IS 3589 of thickness specified.

PIPE FITTINGS
Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are needed to complete the piping work in its totality.

Fabricated fittings shall not be permitted for pipe diameters 50 mm and below.

When used, they shall be fabricated, welded and inspected in workshops under supervision of Engineer-in-Charge whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

**JOINTING**

**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 MS forged fittings)

**Welding (65 mm dia and above)**

Joints between MS pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor. (With welded M.S. fittings heavy class with V-Groove). The welding machine shall be 3 Phase rectifier of required current and capacity. The vendor for welding will be approved by Engineer-in-Charge.

**Flanges**

Flanged joints shall be provided on:

- Straight runs not exceeding 30 m on pipelines 80 mm dia and above.
- Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.
- 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.
- Flanges shall be as per IS 6392-1971, Table 17/18 with appropriate number of G.I. nuts and bolts, half threaded of with 3 mm insertion neoprene gasket complete.

**Unions**

Provide Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges shall be provided.

**PIPE PROTECTION**

All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer and two or more coats of Synthetic Enamel Paint of approved shade.
All black steel pipes under floors or below ground shall be provided with protection against corrosion by application of 100mm wide and 4mm thick layer of PYPKOTE/ MAKPOLYKOTE over the pipe, as per manufacturers specifications.

PIPE SUPPORTS

All pipes shall be adequately supported from or walls from existing/new inserts by Structural clamps fabricated from M.S. Structural e.g. Rods, Channels, Angles and Flats as per details given in drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.

Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and s by drilling holes with Electrical drill in an approved manner as recommended by the manufacturer of the fasteners.

TESTING

All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure or minimum of 15 kg/cm² without drop in the pressure for at least 2 hours.

Rectify all leakages, make adjustment and retest as required.

ANCHOR BLOCK

Contractor shall provide suitable cement concrete, anchor blocks of ample dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

VALVES

Valves, Gauge and Orifice Plates

Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1980, valves up to 65mm shall be of Gunmetal Full way Valve with wheel tested to 20 kg/cm² class-II as per I.S: 778-1971. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.

Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type.

EXTERNAL YARD HYDRANTS

The Contractor shall provide External Fire Hydrant in the Ring or on External Fire Line, as per specifications and as shown in drawings. The spacing of the hydrants and the distance from the building shall be maintained as per relevant requirements of latest relevant codes, unless specified herewith.
Each External Fire Hydrant shall be provided with an External Fire Hose Cabinet of M.S of size 76.8 x 61.44 x 25.80 cm, as approved by the Architect to equip 2 nos. of 63 mm dia controlled percolating hose and accessories as required. The cabinet shall be installed near the Hydrant as per details, approved by the Engineer-in-Charge / Architect.

INTERNAL HYDRANTS


A cap with chain is provided on one head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.

The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.

FIRST-AID HOSE REEL EQUIPMENT

First aid hose reel equipment shall comprise reel, hose guide fixing bracket hose tubing globe valve, stopcock and nozzle. This shall conform to IS:884 - 1969. The hose tubing shall confirm to IS:1532-1969.

The hose tubing shall be 20 mm dia and 36.5m long. The GM nozzle 5mm and globe valve shall be of 20 mm size.

The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the MS pipe riser taken independently from ring.

HOSE PIPES, BRANCH PIPES AND NOZZLES

Hose Pipes

Two numbers Hose Pipes shall be rubber lined woven jacketed and 63mm in dia. 15m long. They shall confirm to type A (Reinforced rubber lined) of IS:636 - 1979. The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

BRANCH PIPE

Branch Pipes

Branch pipe shall be of Gunmetal 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.
Nozzle

The nozzle shall be of Gunmetal 20 mm in (internal) diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.

Two C.P hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

HOSE CABINET

The internal hose cabinet shall accommodate the Hose pipes, branch pipe, Nozzle First aid Hose Reel and Hydrant Outlets and shall be fabricated from 2 mm thick or 14 mm gauge MS/aluminum sheet. The overall size shall be 2100x900x715 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with.

The hose cabinet shall be painted red and stove enameled and woods FIRE written in front glazed portion.

FIRE BRIGADE INLET CONNECTIONS

Fire Brigade Inlet connection shall be provided near the pump house and to the wet riser system as specified, for the following purposes:

- Fire Brigade suction connection for fire static tank with provision of foot valve.
- Fire brigade inlet connection to fire static tank.
- Fire brigade inlet connection to the wet riser system. Each connection shall be provided with similar dia of Sluice valve and Non return valve.

The locations of this Fire brigade connection shall be suitably decided with the approval of Consultant/Landscape Architect and with a view that these are easily accessible to the fire brigade, without any possible Hindrance.

HYDRAULIC SIREN

A siren shall be provided in the system, to indicate the flow of water in the wet riser system. Alternative arrangements may also be adopted. This shall be turbine type.

VALVE CHAMBERS

Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick 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.

Valve chambers shall be of following size:

- For depths 100 cm and beyond 90x90x100 cm

**PORTABLE FIRE EXTINGUISHER**

Portable fire extinguishers shall be provided as per the drawing and shall confirm to IS:2190-1979.

- Two 9 lit. water CO2 type for every 600 m2 area with minimum of 1 extinguishers per floor as per IS:15683
- Dry Chemical powder type of 6 Kg. Capacity as per IS:15683
- CO2 type of 4.5 kg capacity as per IS:15683.

**SPRINKLER HEADS**

Sprinkler heads shall be provided at approximate spacing to cover 9 to 12 m2 per Sprinkler head. The spacing shall however, be in conformity with the drawings and properly coordinated with Electrical Fixtures, Ventilation Ducts and Grills and other services along the .

Sprinkler heads shall be chrome finished Brass/Gunmetal with quartz bulb with a temperature rating of 68°C. Sprinkler heads shall be of type and quality approved by the local fire brigade authority. The inlet shall be screwed. Sprinkler heads shall be pendent, recessed or special application side wall Sprinkler types as shown in drawings. All Sprinklers should have the Specifications.

Contractor shall supply spare Sprinkler Heads of each type as per requirement and one Spanner for each type of sprinkler neatly installed in a steel box with glass shutters at locations approved by the Engineer-in-Charge.

**ALARM VALVE & AUTOMATIC WATER MOTOR GONG VALVE**

The alarm valve & water motor gong valve UL approved shall be provided on the Sprinkler main delivery pipe complete in all respects.

**SHOP DRAWINGS & SPECIFICATIONS**

The Contractor shall submit to the Consultant two copies of Shop Drawings for Fire Fighting works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit six copies of Shop Drawings for execution to the Engineer-in-Charge. Also the Contractor shall submit four copies of the Technical Specifications and Catalogues.

Shop drawings shall be submitted for the following conditions:

- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Fire Fighting layout plans as required and for any changes in the layout of Fire Fighting/Architectural drawings.

The Contractor can only commence the work after the approval of above documents by Consultant.
SECTION – XIII: WATER SUPPLY/FIRE FIGHTING PUMPS & EQUIPMENTS AND WATER TREATMENT UNITS ETC.

PUMPS AND WATER TREATMENT EQUIPMENT

Work under this sub-head consists of furnishing all labor, materials, equipment and accessories necessary and required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter.

Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

- Raw water pumps.
- Hydro pumps for Domestic water.
- Soft water transfer pumps.
- Garden Hydrant Pumps.
- Hot water recirculation pumps.
- Treated water supply pumps to STP (Emergency supply)
- Sump pumps for disposal of sewage and drainage.
- Water treatment unit consisting of filter, softener and chlorination etc.
- Fire pumps.
- Motor control panels, power and control cabling and allied electrical works.
- Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

PUMP SET
Water Supply Pumps (Raw Water / Soft Water / Garden Hydrant / Hot Water Recirculation Pump)

Water supply pumps shall be suitable for clean water. Pumps shall be multistage, monoblock vertical centrifugal pumps with Cast Iron body and Cast Iron impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal “Burden” type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.
Hydro Pneumatic System (Domestic & Flushing Water Supply Pumps)

Domestic water supply pumps shall be packaged type skid mounted hydro pneumatic system with fixed speed system. Complete system to be mounted on a common base frame.

Pumps shall be multistage, monoblock vertical centrifugal pumps with stainless steel body and stainless steel impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pressure vessel of non corrosive FRP composite construction lined with NSF and/or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of 5 times the vessel operating pressure and cycle tested for 2,50,000 cycles. No. and capacity of Pressure Vessel As per manufacturer recommendation.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal “Burden” type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.

Pumps shall have Control Panel with programmable logic controller (PLC) for cyclic operation of pumps. Pump working sequence should change after every operation. Contractor overload relays and MCBs should confirm to IEC 898 – 1995/ specifications. Blinking indications for pumps start, trip, low level trip, and health supply should be provided in the panel along with the ammeter & voltmeter. Control panel should also consist of cooling fan.

SUMP PUMP

Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage. Pump with impeller of approved material shall be mounted on waterproof motor. The impeller shall be suitable for handling solids upto 46-100mm dia.

The pump shall automatically operate with high water level and stop at low water level in the sump by means of “Electronic Level Controller”, of the approved make.

The sump pumps shall be complete in all respect and shall be installed as per manufacturer’s requirement as shown in the drawing. All accessories shall be In-Built as per manufacturer’s specification.

Sump pumps are compact monoblock dry motor submersible pumps for suitable rating, with non-clog free flow open impeller, minimum solid handling capacity up to 100mm for sewer & 40 for storm water . Suitable for operation on 415 volts + 5% -15%, 50 C/s A.C 3 phase supply, speed 960/1440R&M including oil chamber, guide wire for lifting & lowering of pump, M.S. galvanized lifting chain, duck foot bend.
The above pump sets must be supplied complete with following accessories:

- Complete piping 100mm dia common delivery upto 1.5m as shone in the drawing. (The pipe should be preferably heavy duty GI)
- Necessary valve i.e Butterfly valve on delivery/suction side and Non return valves are on delivery side.
- Necessary cable from pumps set to control panel.
- Electrical switch panel having all necessary accessories & safety devices of standard specifications. (Panels with sump pumps near each sump as per site conditions)
- Automatic built-up water level controller with necessary length of cable upto control panel.

**FIRE FIGHTING PUMPS**

**Electrical Operated Main Fire, Sprinkler and Jockey Pumps**

Pumping sets shall be single stage horizontal centrifugal single outlet with cast iron body and dynamically balanced bronze impellers. Connecting shaft shall be of stainless steel with bronze sleeve and grease-lubricated bearings.

Pumps shall be connected to the drive by means of spacer type love-joy coupling which shall be individually balanced dynamically and statically.

The coupling joining the prime mover with the pump shall be provided with a sheet metal guard.

Pumps shall be provided with approved type of mechanical seals.

Pumps shall be capable of delivering not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut-off head shall not exceed 120% of the rated head.

The System shall meet the requirements of the National building Code 2005 (NBC).

Necessary 'Y' strainer on the suction side and pressure gauge with GM cocks on the delivery side including bypass arrangement (with 50 valve and up to 5M G.I. Medium pipes) for periodical testing of the working of the pumping set shall be provided.

Pump shall be mounted on common base frame fabricated from MS channel as per manufacturer's specification.

Suitable RCC Pump-foundations as per manufacturer's design and 4 nos. Dunlop (cushy foot) heavy duty Ant vibration mounting pads shall be provided.

**Motors for Electric Driven Pumps**

Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors.

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.

Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.
Motors shall be suitable for 415 volts, 3 Phase, 50 cycles A.C supply and shall be designed for 33°C ambient temperature. Motors shall conform to I.S: 325.

Motors shall be designed for two start system.

Motors shall be capable of handling the required starting torque of the pumps.

Contractor shall provide heating arrangements for the main fire pump motor to ensure that motor windings shall remain dry.

**Air Vessel for Fire Pumps**

Provide an air vessel fabricated from 10mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mm in dia and 2000 mm high and tested to 10.0Kg/cm2 pressure.

The fire pumps shall operate on drop of 1 Kg/cm2 pressure in the mains. 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.

**Operating Conditions for the Service Pumps**

<table>
<thead>
<tr>
<th>Fire Pump</th>
<th>Service Nos.</th>
<th>Cut in Pressure</th>
<th>Cut Out Pressure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jockey pump</td>
<td>One</td>
<td>8.2 kg/cm2</td>
<td>6.7 kg/cm2</td>
<td>To auto start and auto stop on pressure switch on air vessel.</td>
</tr>
<tr>
<td>Main pump</td>
<td>One</td>
<td>6.2 kg/cm2</td>
<td>Push button manual</td>
<td>To auto start on pressure switch on air vessel and manual off.</td>
</tr>
<tr>
<td>Diesel Fire Pump</td>
<td>One</td>
<td>5.7 kg/cm2</td>
<td>Push button manual</td>
<td>To auto start on pressure switch on air vessel and manual off.</td>
</tr>
<tr>
<td>Sprinkler Pump</td>
<td>One</td>
<td>6.7 kg/cm2</td>
<td>Push button manual</td>
<td>To auto start on pressure switch on air vessel and manual off.</td>
</tr>
</tbody>
</table>

**Diesel Fire Pump**

**Scope**

This section covers the details of requirements of the standby fire pump, operated by a diesel engine.

**General**

The diesel pump set shall be suitable for automatic operation, complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common bed plate, fabricated from mild steel channel.
Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1450/1800 rpm.

Fire Pump

The fire pump shall be horizontal split casing centrifugal type. It shall have a capacity to deliver 2280 lpm as specified, developing adequate head so as to ensure a minimum pressure of 3.5 Kg. per cm² at the highest and the farthest outlet. The delivery pressure at the pump outlet shall be not less than 8 Kg. per cm² in any case. The pump may be single stage or multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the Rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to I.S: 210 and parts like impeller shaft sleeve, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gunmetal. The shaft shall be of stainless steel. The pump shall be provided with mechanical seal.

Bearings of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

Diesel Engine

Environmental Conditions - The engine shall be required to operate under the conditions of environment as required as per site conditions.

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater plugs etc). The engine shall be multi cylinder/vertical 4 stroke cycle, water cooled diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and after correction for altitude, ambient temperature and humidity for the specified environmental conditions as mentioned. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and at least 3000 hours of operation before major overhaul. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run.

The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to B.S: 649/I.S: 1601/I.S: 10002, all amended up to date.

Engine Accessories - The engine shall be complete with the following accessories:-

- Fly sheet dynamically balanced.
- Direct coupling for pump and Coupling Guard.
- Radiator with hoses, fan, water pump, drive arrangement and guard.
- Corrosion Resister
- Air cleaner, oil bath type/dry type
- Fuel service tank support, semi-rotary pump and fuel oil filter with necessary pipe work.
- Pump for lubricating oil and lub. oil filter
• Elect. starting battery (2x12 v)
• Exhaust silencer with necessary pipe work
• Governor
• Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).
• Necessary safety controls
• Winterization arrangement, where specified.

**Cooling System** - The engine cooling system shall be radiator water cooled system. The radiator assembly shall be mounted on the common bed plate. The radiator fan shall be driven off the engine as its auxiliary with a multiple fan belt. When half the belts are broken, the remaining belts shall be capable of driving the fan. Cooling water shall be circulated by means of an auxiliary pump of suitable capacity driven by the engine in a closed circuit.

**Fuel System** - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on brackets at a height not less than 60 cm above the fuel injection pump. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3mm thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary floor mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet should be so located as to avoid entry of any sediment into the fuel line to the engine.

A semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of work.

**Lubricating Oil System** - Forced feed lub. oil system shall be employed for positive lubrication. Necessary lub. oil filters shall be provided, located suitably for convenient servicing.

**Starting System** - The starting system shall comprise necessary batteries (2x12 v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. By metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The battery capacity shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

**Exhaust System** - The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories needed for a run of 5 meter from the engine manifold. (Adjustment rates for extra length shall also be given). The total back pressure shall not exceed the engine manufacturer’s recommendation. The exhaust piping shall be suitably lagged.

**Engine Shut Down Mechanism** - This shall be manually operated and shall return automatically to the starting position after use.
**Governing System** - The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

**Engine Instrumentation** - Engine instrumentation shall include the following:-

- Lubricant oil pressure gauge.
- Lubricant oil temperature gauge.
- Water pressure gauge.
- Water temperature gauge.
- Tachometer.
- Hour meter.

The instrumentation panel shall be suitably resilient mounted on the engine.

**Engine Protection Devices** - Following engine protection and automatic shut down facilities shall be provided:

- Low lub. oil pressure
- High cooling water temp.
- High lub. oil temperature
- Over speed shut down.

**Pipe Work** - All pipe line with fittings and accessories required shall be provided for fuel oil, lub. oil and exhaust systems. Copper piping of adequate sizes shall be used for lub. oil and fuel oil. M.S. piping will be permitted for exhaust.

**Anti Vibration Mounting** - Suitable vibration mounting duly approved by Engineer-in-Charge shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

**Battery Charger** - Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

**CABLES**

Contractor shall provide all power control cables from the motor control center to various motors, level controllers and other control devices.

Cables shall conform to I.S: 1554 and carry ISI mark.

Wiring cables shall conform to I.S 694.

All power and wiring cables shall be aluminum conductor PVC insulated armored and PVC sheathed of 1100 volts grade.

All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.

All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer’s name.
All cable joints shall be made in approved manner as per standard practice.

**CABLE TRAYS**

Contractor shall provide M.S slotted cable trays at locations as shown on the drawings.

Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by anchor fasteners.

**EARTHING**

There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armor clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sweated.

Earth plates shall be buried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

A brick masonry manhole 30x30x30cm size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

**CONTROL PANELS / STARTERS**

Switch board cubicles of approved type shall be fabricated from 16-gauge M.S. sheet with dust and vermin proof construction. It shall be painted with powder-coated finish of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the followings:-

- Incoming main isolation MCCB of required capacity.
- Fully Aluminum taped Bus Bar of required capacity.
- Isolation MCCB one for each motor.
- Fully automatic as specified D.O.L/Star Delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps. (DOL up to 7.5 HP and Star Delta from more than 7.5 H.P)
- Single phase preventer of appropriate rating for each motor.
- Panel type ampere meters one for each motor with selector switch.
- Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.
- Neon phase indicating lamps for incoming main and on/off indicating lamps for each motor.
- Rotary switch for manual or auto operation for each pump (manual/auto off).
• Fully taped separate aluminum bus bars of required capacity and with required outlets.
• Space for liquid level controllers as specified + 1 extra space.
• The panel shall be pre-wired with color-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.
• Provision of main incoming cables from the top of the panel.

All switch gears and accessories shall be of approved make such as “Siemens, Larsen & Toubro” or equivalent.

Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers. All floor-mounted switchboards shall rest on minimum 225mm high platform. The contractor shall provide the shop drawings for base and panels.

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. Length of the connector shall be as per manufacturer’s details.

ILLUMINATED FACSIMILE ANNUNCIATOR PANEL

Scope
Scope of this section comprises the supply, installation, testing and commissioning of illuminated facsimile annunciation panel.

Illuminated Facsimile Enunciator

Illuminated facsimile enunciator shall be provided with facsimile of the building, constructed of acrylic panels of suitable dimensions, showing the Basement, Ground floor plans and section showing the location of Zonal Panels on each typical floor, entry points, various facilities shown with enamels in various colors.

Alarm lights to indicate fire location shall be arranged within the acrylic panel and shall be either automatically lighted by operation of any automatic fire detection devices or manual station, or by control of push button incorporated in the control desk.

Indicator of each building or facility shall include two lamps connected in parallel and so arranged that the failure of either of the lamps is readily apparent when a call or test is made.

Power for the Enunciator shall be supplied from the power supply for the control desk.

Representation of the various plans/Drawings on the acrylic of the Enunciator shall be by negative film processing with colored Discrimination of various zones for which the drawings shall be furnished for approval.

WATER FILTER

Water filter shall be of dual filter media pressure filter downward or upward flow type suitable for a rate of filtration.
Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure as given below. The minimum thickness of shell will be 8mm and dished ends shall be 10mm. The filter shall have at least one pressure tight manhole cover.

Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non-toxic corrosion resistant paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

**Under Drain System**

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer’s design. The entire under drain system be provided on M.S. plate or cement concrete supports.

**Face Piping**

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I/M.S. piping, medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern with C.I. body and Neoprene rubber diaphragm.

**Accessories**

Each filter shall be provided with following accessories:-

- Air release valve with connecting piping.
- 150mm dia dial burden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- Sampling cocks on raw water inlet and filtered water outlet.
- Individual drain connection with gunmetal full way valve.
- Connection with valve for air scouring.

**WATER SOFTENER**

Softener shall be designed to give zero commercial hardness. Softener shall be with cation exchange resins.

Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a working pressure. The shell shall have a minimum thickness of 8mm and dished ends 10mm. The vessel shall be painted internally with non-toxic bitumen paint and externally with one coat of red oxide and two or more coats of synthetic paint to give an even shade.

The vessel shall have an internal collecting and distribution system of manufacturer’s design.

The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be M.S. medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern, with C.I. body and Neoprene rubber diaphragm (suggested make LABLINE, NKI or equivalent).
One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicator.

One cylindrical salt saturator and measuring tank of M.S. rubber lined having a capacity of a minimum of two regenerations for.

One orifice board for indicating wash and rinse rate to be fitted in drain sump.

One charge of supporting gravel, sand and “cation” resin in requisite quantity. Resin shall be Indian 220 or approved equivalent make.

One water testing kit with instructions for testing water samples.

**PIPING**

Pipes for suction and delivery shall be galvanized/M.S tube (heavy duty) confirming to I.S:1239 up to 150mm dia and as per I.S:3589 for dia 200mm and above. The M.S flanges shall confirm to I.S:6392-1971.

Gate valve and check valve above 65mm dia shall be C.I. double flanged conforming to I.S:780 manufactured by the reputed manufacturers or C.I. double flanged butterfly valves.

Full way and check valves 65mm dia and below shall be gunmetal tested to 20Kg/cm² pressure certified and conforming to I.S:778.

Suction strainer or foot valves shall be C.I., confirming to I.S:4038 - 1979.

**Joints**

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers etc.

**Testing**

All G.I pipes (except fire pipe) shall be tested hydrostatically for a period of 30 minutes to a pressure of 7 Kg/cm² without drop in pressure and all G.I pipes for fire shall be tested hydrostatically for a period of 30 minutes to a pressure of 10 Kg/cm² without drop in pressure.

**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 form of warranty shall be as approved by the Engineer-in-Charge.

The warranty shall be valid for a period of one 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.
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 Hospital 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 in the hospital as per International Standard as given in the attached guidelines.

REQUIRED QUALITY OF TREATED WATER

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Characteristics</th>
<th>Acceptable as per Indian Standard of P.H.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Turbidity (Units on J.T.U scale)</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>Colour (Units on Platinum Cobalt scale)</td>
<td>5.0</td>
</tr>
<tr>
<td>3</td>
<td>Taste and Odour</td>
<td>Unobjectionable</td>
</tr>
<tr>
<td>4</td>
<td>pH</td>
<td>7.0 to 8.5</td>
</tr>
<tr>
<td>5</td>
<td>Total dissolved solids (mg/l)</td>
<td>500</td>
</tr>
<tr>
<td>6</td>
<td>Total hardness (mg/l) (as CaCO3)</td>
<td>200</td>
</tr>
<tr>
<td>7</td>
<td>Chlorides (as Cl) (mg/l)</td>
<td>200</td>
</tr>
<tr>
<td>8</td>
<td>Sulphates (as SO4)</td>
<td>200</td>
</tr>
<tr>
<td>9</td>
<td>Fluorides (as F) (mg/l)</td>
<td>1.0</td>
</tr>
<tr>
<td>10</td>
<td>Nitrates (as NO3) (mg/l)</td>
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</tr>
<tr>
<td>11</td>
<td>Calcium (as Ca) (mg/l)</td>
<td>75</td>
</tr>
<tr>
<td>12</td>
<td>Magnesium (as Mg) (mg/l)</td>
<td>&gt; 30</td>
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<tr>
<td>13</td>
<td>Iron (as Fe) (mg/l)</td>
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</tr>
<tr>
<td>14</td>
<td>Manganese (as Mn) (mg/l)</td>
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</tr>
<tr>
<td>15</td>
<td>Copper (as Cu) (mg/l)</td>
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<tr>
<td>16</td>
<td>Zinc (as Zn) (mg/l)</td>
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<tr>
<td>17</td>
<td>Phenolic compounds (as Phenol) (mg/l)</td>
<td>0.001</td>
</tr>
<tr>
<td>18</td>
<td>Anionic detergents (mg/l) (as MBAS)</td>
<td>0.2</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Characteristics</td>
<td>Acceptable as per Indian Standard of P.H.E.</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>19</td>
<td>Mineral Oil (mg/l)</td>
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</tr>
<tr>
<td>20</td>
<td>Arsenic (as As) (mg/l)</td>
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</tr>
<tr>
<td>21</td>
<td>Cadmium (as Cd) (mg/l)</td>
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<tr>
<td>22</td>
<td>Chromium (as hexavalent Cr) (mg/l)</td>
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</tr>
<tr>
<td>23</td>
<td>Cyanides (as CN) (mg/l)</td>
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</tr>
<tr>
<td>24</td>
<td>Lead (as Pb) (mg/l)</td>
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</tr>
<tr>
<td>25</td>
<td>Selenium (as Se) (mg/l)</td>
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</tr>
<tr>
<td>26</td>
<td>Mercury (total as Hg) (mg/l)</td>
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<tr>
<td>27</td>
<td>Polynuclear Aromatic Hydrocarbons (PAH)</td>
<td>0.2 ug/l</td>
</tr>
<tr>
<td>28</td>
<td>Gross Alpha activity</td>
<td>3p Ci/l</td>
</tr>
<tr>
<td></td>
<td>Gross Beta activity Pci = pico curie</td>
<td>30p Ci/l</td>
</tr>
<tr>
<td>29</td>
<td>Bacteriological Quality of piped water supplies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treated water entering the distribution system</td>
<td></td>
</tr>
<tr>
<td>29.1</td>
<td>Faecal coliforms number/100 ml</td>
<td>0</td>
</tr>
<tr>
<td>29.2</td>
<td>Coliform organisms number/ 100 ml</td>
<td>0</td>
</tr>
</tbody>
</table>
HVAC
A) BASIS OF DESIGN

i) Basis of Design

1. **Site Location**
   Sundergarh, Odisha, India
   - Geographic Location: 22.12° N & 84.03° E
   - Altitude: 233 Meters

2. **Introduction**
   A centralized HVAC system shall be designed, installed & commissioned to provide thermally controlled environment for the proposed College & Hospital. The HVAC systems shall be designed for automated round the clock year round operation to provide for the Inside environmental conditions as specified below.

3. **Objective**
   To achieve GRIHA Rating 3 (Green Rating for Integrated Habitat Assessment) as per Green Building rating System in India. The HVAC contractor shall be equally responsible for achieving this certification along with GRIHA Consultant. The HVAC Contractor shall provide complete details & documents as required by the GRIHA Consultant for certification & shall work in consultation with GRIHA Consultant & HVAC Consultant.

4. **Outside design conditions**
<table>
<thead>
<tr>
<th>Season</th>
<th>DBT °C</th>
<th>WBT °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>43.30</td>
<td>25.00</td>
</tr>
<tr>
<td>Monsoon</td>
<td>34.40</td>
<td>28.90</td>
</tr>
<tr>
<td>Winter</td>
<td>13.30</td>
<td>08.90</td>
</tr>
</tbody>
</table>

5. **Inside Design Conditions**
<table>
<thead>
<tr>
<th>DBT °C</th>
<th>RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer Design Parameters Given Below</td>
<td></td>
</tr>
</tbody>
</table>

5. **Filtration**: Pre filters of rating MERV 8, Fine Filters or MERV rating 13 shall be installed in the AHU as specified in the BOQ. Hepa filters shall be in laminar flow OT plenum & in the scope of OT contractor.

6. **Exposed Roof**: All exposed roof / terraces shall be insulated with 75 mm thick expanded polystyrene or equivalent material by HVAC Contractor to get an overall heat transmission factor of 0.06 BTU/HR/SFT/°F.

7. **Power Supply**: Stabilised three phase four wire AC supply i.e. 415 Volts ± 10 % & 50 Hz ± 5 % with double earthing shall be made available near Main Panel / Sub Panels of Fans, AHUs etc & Single-phase power supply with earthing near each inline fan etc or wherever as required by electrical contractor.

8. **Note**: Curtain glass shall have Overall Transmission Gain Factor & Solar Gain Factor of 2.64 w/m²/°K.
### Parameters for Air Conditioned Area With AC Load & Equipment Selected

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Floor &amp; Area Name</th>
<th>AC Area, SFT</th>
<th>Inside Temp. in °C</th>
<th>Relative Humidity (RH) %</th>
<th>Light W / SFT</th>
<th>Occupancy</th>
<th>Equip. Load, Watt</th>
<th>Fresh Air Qty, In CFM</th>
<th>TR Summer</th>
<th>Calcu. Dehum. CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><strong>HOSPITAL BLOCK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Ground Floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Resuscitation, Dressing Room, Examination &amp; Treatment Room, Entrance Room, Triage, Post &amp; Pre OP</td>
<td>5089</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1.5</td>
<td>90</td>
<td>8</td>
<td>1274</td>
<td>34.4</td>
<td>14270</td>
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<tr>
<td>2</td>
<td>Emergency OT</td>
<td>421</td>
<td>20 ± 1</td>
<td>50 ± 5</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>12 Ach (842 CFM)</td>
<td>8.9</td>
<td>2780</td>
</tr>
<tr>
<td>3</td>
<td>Minor OT, Doctor &amp; Nurse Duty Room, ICU, Intensive Care Burn Unit &amp; Corridor</td>
<td>2883</td>
<td>22 ± 1</td>
<td>50 ± 5</td>
<td>1</td>
<td>35</td>
<td>3</td>
<td>2 ACH 864 CFM</td>
<td>18.97</td>
<td>7871</td>
</tr>
<tr>
<td>4</td>
<td>Doctor In charge Room</td>
<td>172</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>3</td>
<td>0.5</td>
<td>43</td>
<td>1.1</td>
<td>462</td>
</tr>
<tr>
<td>5</td>
<td>CMO Room</td>
<td>161</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>3</td>
<td>0.5</td>
<td>42</td>
<td>1.0</td>
<td>433</td>
</tr>
<tr>
<td>6</td>
<td>HOD Room</td>
<td>172</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>3</td>
<td>0.5</td>
<td>43</td>
<td>1.1</td>
<td>462</td>
</tr>
<tr>
<td>7</td>
<td>Departmental Office, Tutor Room, Non Teaching Staff, Assistant Professor, Museum &amp; Demo Room</td>
<td>2872</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>35</td>
<td>2</td>
<td>565</td>
<td>17.95</td>
<td>7449</td>
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<tr>
<td>8</td>
<td>X-ray Room, Ultrasound Room, Entrance Lobby, Registration Counter, Back Office, Space for Mobile X-ray</td>
<td>4906</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>90</td>
<td>8</td>
<td>1260</td>
<td>32.71</td>
<td>13900</td>
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<tr>
<td>S. No.</td>
<td>Floor &amp; Area Name</td>
<td>AC Area, SFT</td>
<td>Inside Temp. In °C</td>
<td>Relative Humidity (RH) %</td>
<td>Light W / SFT</td>
<td>Occupancy</td>
<td>Equip. Load, Watt</td>
<td>Fresh Air Qty In CFM</td>
<td>TR Summer</td>
<td>Calcu. Ductn. CFM</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------------------------------------------</td>
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<td>------------------</td>
</tr>
<tr>
<td>9</td>
<td>MRI, CT Scan &amp; Control Room</td>
<td>1291</td>
<td>21 ± 1</td>
<td>40 - 60 %</td>
<td>1.5</td>
<td>15</td>
<td>25</td>
<td>247</td>
<td>16.14</td>
<td>7423</td>
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<tr>
<td>10</td>
<td>Emergency Ward Male &amp; Female, Nurse &amp; Doctor Duty Room,</td>
<td>2152</td>
<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>35</td>
<td>1</td>
<td>509</td>
<td>13.45</td>
<td>5784</td>
</tr>
<tr>
<td>11</td>
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<td>22 ± 1</td>
<td>40 - 60 %</td>
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<td>8</td>
<td>4</td>
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<td>0</td>
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<td>18</td>
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<td>Post Natal, Eclamsia Recovery, Doctors &amp; Nurses Room, Stage - 1 &amp; 2, Examination Room &amp; Corridor</td>
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## Second Floor

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<th>S. No.</th>
<th>Floor &amp; Area Name</th>
<th>AC Area, SFT</th>
<th>Inside Temp. in °C</th>
<th>Relative Humidity (%)</th>
<th>Occupancy</th>
<th>Equip. Load, Watt</th>
<th>Fresh Air Qty In CFM</th>
<th>TR Summer</th>
<th>Calcu. Dehum. CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>UPS Room (2 x 15 KVA - 1W+1S)</td>
<td>225</td>
<td>22 ± 1</td>
<td>40 - 60 %</td>
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<td>0</td>
<td>18</td>
<td>1.65</td>
<td>780</td>
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<tr>
<td>20</td>
<td>PICU</td>
<td>2184</td>
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<td>20</td>
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<td>21</td>
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<td>1</td>
<td>20</td>
<td>2</td>
<td>610 CFM</td>
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<td>60</td>
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<tr>
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<td>Administration Department, Deputy Med. Super Room, Deputy Nursing Super Room, Board Room, Health &amp; Staff Committee Room, Enquiry Office, PA Room, Hospital Offices for Supporting Staff &amp; Waiting Area &amp; Corridor</td>
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<td>100</td>
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<td>1191</td>
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### Calculations:
- **Fresh Air Quantity**: Calculated as TR Summer x 1000
- **Dehumidification Capacity**: Calculated as fresh air quantity / TR Summer
### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Floor &amp; Area Name</th>
<th>AC Area, SFT</th>
<th>Inside Temp. In °C</th>
<th>Relative Humidity (RH) %</th>
<th>Light W / SFT</th>
<th>Occupancy</th>
<th>Equip. Load, Watt</th>
<th>Fresh Air Qty In CFM</th>
<th>TR Summer</th>
<th>Calc. Dehum. CFM</th>
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</thead>
<tbody>
<tr>
<td><strong>Third Floor</strong></td>
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<tr>
<td>27</td>
<td>Minor OT</td>
<td>473</td>
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<td>1</td>
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<td>RICU, Examination Room, Tutor, Assistant Associate Prof., Doctor On Duty &amp; Counseling Room, Waiting Lobby</td>
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<td>60</td>
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<tr>
<td>29</td>
<td>MICU, Doctor &amp; Nurse Duty Room</td>
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<td>15</td>
<td>2</td>
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<tr>
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<td>Counseling, Assistant Room, Demo Room, Non Teaching Staff &amp; Departmental Office, Tutor / Registrar / Senior Resident &amp; Corridor</td>
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<td>23 ± 1</td>
<td>40 - 60 %</td>
<td>1</td>
<td>75</td>
<td>4</td>
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<tr>
<td>32</td>
<td>SICU, Doctor &amp; Nurse Duty Room</td>
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<td>50 ± 5 %</td>
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<tr>
<td>33</td>
<td>Counseling, Assistant Room, Demo Room, Non Teaching Staff &amp; Departmental Office, Tutor / Registrar / Senior Resident &amp; Corridor</td>
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<td>23 ± 1</td>
<td>40 - 60 %</td>
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<td>954</td>
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<tr>
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<td>4 Nos. HOD Room (Each Area 236 Sft)</td>
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<td>12</td>
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<td>S. No.</td>
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<td>AC Area, SFT</td>
<td>Inside Temp. In °C</td>
<td>Relative Humidity (RH) %</td>
<td>Light W / SFT</td>
<td>Occupancy</td>
<td>Equip. Load, Watt</td>
<td>Fresh Air Qty In CFM</td>
<td>TR Summer</td>
<td>Calcu. Dehum. CFM</td>
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<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------</td>
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<td>----------------------</td>
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<td>36</td>
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<td>6</td>
<td>3</td>
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<td>50 ± 5 %</td>
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<td>6</td>
<td>3</td>
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<td>12 Ach (774 CFM)</td>
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<td>50 ± 5 %</td>
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<td>6</td>
<td>3</td>
<td>12 Ach (774 CFM)</td>
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<td>50 ± 5 %</td>
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<td>6</td>
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## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

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<th>Relative Humidity (%)</th>
<th>Occupancy</th>
<th>Equip. Load, Watt</th>
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<th>TR Summer</th>
<th>Calcu. Dehum. CFM</th>
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</table>
### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

| S. No. | Floor & Area Name | AC Area, SFT | Inside Temp. In °C | Relative Humidity (RH) % | Light W / SFT | Occupancy | Equip. Load, Watt | Fresh Air Qty In CFM | TR Summer | Calcu. Dehum. CFM |
|--------|------------------|--------------|---------------------|--------------------------|---------------|-----------|------------------|----------------------|           |                |
| 52     | UPS Room (3 x 60 KVA - 2W+1S) | 421 | 22 ± 1 | 40 - 60 % | 1 | 0 | 10 | 33 | 4.50 | 2115 |
|        | **Fourth Floor** |              |                     |                          |               |           |                  |                      |           |                |
| 53     | Library Hall     | 10770        | 23 ± 1              | 40 - 60 %                | 1             | 225       | 1                | 3034                | 71.80     | 30874          |
| 54     | Library Hall     | 7488         | 23 ± 1              | 40 - 60 %                | 1             | 190       | 1                | 2437                | 49.92     | 21216          |
| 55     | Demo Room        | 473          | 23 ± 1              | 40 - 60 %                | 1             | 40        | 0.5              | 427                 | 2.78      | 1196           |
|        | **Sub Total Medical College** | **41251** |                       |                          |               |           |                  |                      | **275.1** |                |
|        | **Total (Hospital + Medical College)** | **123151** |                       |                          |               |           |                  |                      | **861.7** |                |
## 10. AHU & FCU Sections Details

<p>| S. No. | Floor &amp; Area Name | Equipment Selected | Zone - 1 (24 Hrs. Working) | Zone - 2 (12 Hrs. Working) | No. Of AHU / FCU | Pipe Size (CC) In MM | No. Of Row (CC) | Pipe Size (HC) In MM | No. Of Row (HC) | Humidifier | Fine Filters | Hepa Filters | No. of Points | Kw of each Point | Total Kw |
|--------|-------------------|-------------------|------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|-------------|--------------|--------------|---------------|----------------|----------|
| A      | HOSPITAL BLOCK    |                   |                  |                  |                 |                 |                 |                 |                 |                |             |              |              |               |               |          |
|        | Ground Floor      |                   |                  |                  |                 |                 |                 |                 |                 |                |             |              |              |               |               |          |
| 1      | Resuscitation, Dressing Room, Examination &amp; Treatment Room, Entrance Room, Triage, Post &amp; Pre OP | AHU/Gr/1- 15,000 CFM, F/M | 34.4 | 0 | 1 | 80 | 6 | NA | NA | NA | NA | NA | 1 | 9.3 | 9.30 |
| 2      | Emergency OT      | AHU/Gr/2- 3,000 CFM, F/M | 8.9 | 0 | 1 | 50 | 8 | 32 | 2 | 3 | Yes | Yes | 1 | 8.0 | 8.00 |
| 3      | Minor OT, Doctor &amp; Nurse Duty Room, ICU, Intensive Care Burn Unit &amp; Corridor | AHU/Gr/3- 8,000 CFM, F/M | 18.97 | 0 | 1 | 50 | 6 | 32 | 2 | 3 | Yes | NA | 1 | 5.5 | 5.50 |
| 4      | Doctor In charge Room | 1 x 1.5 TR FCU | 0 | 1.1 | 1 | 25 | 4 | NA | NA | NA | NA | NA | 1 | 0.12 | 0.12 |
| 5      | CMO Room          | 1 x 1.5 TR FCU    | 0 | 1.0 | 1 | 25 | 4 | NA | NA | NA | NA | NA | 1 | 0.12 | 0.12 |
| 6      | HOD Room          | 1 x 1.5 TR FCU    | 0 | 1.1 | 1 | 25 | 4 | NA | NA | NA | NA | NA | 1 | 0.12 | 0.12 |
| 7      | Departmental Office, Tutor Room, Non Teaching Staff, Assistant Professor, Museum &amp; Demo Room | AHU/Gr/4- 8,000 CFM, F/M | 0 | 17.95 | 1 | 50 | 6 | NA | NA | NA | NA | NA | 1 | 5.50 | 5.50 |
| 8      | X-ray Room, Ultrasound Room, Entrance Lobby, Registration Counter, Back Office, Space for Mobile X-ray | AHU/Gr/5- 15,000 CFM, F/M | 0 | 32.71 | 1 | 80 | 6 | NA | NA | NA | NA | NA | 1 | 9.30 | 9.30 |
| 9      | MRI, CT Scan &amp; Control Room | AHU/Gr/6- 7,500 CFM, F/M | 0 | 16.14 | 1 | 50 | 6 | 32 | 2 | NA | Yes | NA | 1 | 5.50 | 5.50 |</p>
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<th>S. No.</th>
<th>Floor &amp; Area Name</th>
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<th>Zone - 1 (24 Hrs. Working)</th>
<th>Zone - 2 (12 Hrs. Working)</th>
<th>No. Of AHU / FCU</th>
<th>Pipe Size (CC) In MM</th>
<th>No. Of Row</th>
<th>Pipe Size (HC)</th>
<th>No. Of Row</th>
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<th>Fine Filters</th>
<th>Hepa Filters</th>
<th>No. Of Points</th>
<th>Kw of each Point</th>
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### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

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<th>No. Of AHU/FCU</th>
<th>Pipe Size (CC) In MM</th>
<th>No. Of Row (CC)</th>
<th>Pipe Size (HC) In MM</th>
<th>No. Of Row (HC)</th>
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### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

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<tr>
<th>S. No.</th>
<th>Floor &amp; Area Name</th>
<th>Equipment Selected</th>
<th>Zone - 1 (24 Hrs. Working)</th>
<th>Zone - 2 (12 Hrs. Working)</th>
<th>No. Of AHU/FCU</th>
<th>No. Of Row (CC)</th>
<th>Pipe Size (CC) In MM</th>
<th>No. Of Row (HC)</th>
<th>Pipe Size (HC) In MM</th>
<th>No. Of Points</th>
<th>Kw of each Point</th>
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Page 164
## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

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<th>S. No.</th>
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<th>No. Of Row (CC)</th>
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<th>No. Of Row (HC)</th>
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<td>44</td>
<td>Waiting Area, Anesthetic Room, Nurse Room, Assistant Room</td>
<td>AHU/5F/9- 9000 CFM, F/M</td>
<td>18.76</td>
<td>0.00</td>
<td>1</td>
<td>50</td>
<td>6</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
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<tr>
<td>45</td>
<td>2 Nos. HOD Room (Each Area 236 Sft)</td>
<td>2 x 2.0 TR FCU</td>
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<td>2.95</td>
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<td>25</td>
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<tr>
<td>46</td>
<td>Endoscopy Room</td>
<td>AHU/5F/10- 3500 CFM, F/M</td>
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<td>1</td>
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<td>8</td>
<td>32</td>
<td>2</td>
<td>3</td>
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## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
<thead>
<tr>
<th>Ground Floor</th>
<th>Medical College</th>
<th>Total (Hospital Block)</th>
<th>298.8</th>
<th>287.84</th>
<th>62</th>
<th>61</th>
<th>210.18</th>
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<tr>
<td>47 Examination Hall</td>
<td>AHU/Gr/1 &amp; 2- 16,000 CFM, F/M</td>
<td>NA</td>
<td>66.40</td>
<td>2</td>
<td>80</td>
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<tr>
<td>48 Deans Room &amp; Rest Room</td>
<td>1 x 2.5 &amp; 1 x 1.0 TR FCU</td>
<td>NA</td>
<td>2.96</td>
<td>2</td>
<td>32 &amp; 25</td>
<td>4</td>
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<tr>
<td>49 Meeting Room, PA Room, Waiting Area &amp; Superintendent Room</td>
<td>AHU/Gr/3- 3,500 CFM, F/M</td>
<td>NA</td>
<td>7.21</td>
<td>1</td>
<td>40</td>
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<tr>
<td>First Floor</td>
<td>Lecturer Theatre - 1 &amp; 2 (Each Area 2776 Sft)</td>
<td>AHU/1F/1 &amp; 2- 9,000 CFM, F/M</td>
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<td>51 Lecturer Theatre</td>
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<tr>
<td>52 UPS Room (3 x 60 KVA - 2W+1S)</td>
<td>2 x 5.5 TR Ductable Split (1W+1S)</td>
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<td>0.00</td>
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<td>Library Hall</td>
<td>AHU/4F/1 &amp; 2 - 16,000 CFM, F/M</td>
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### Parameters for Mechanically Ventilated Area with Equipment Selection

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<th>S/N</th>
<th>Floor</th>
<th>Area (SFT)</th>
<th>Effective %</th>
<th>Volume @ CFT</th>
<th>Air Change</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kw</th>
<th>3 / 1 Phase</th>
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<tbody>
<tr>
<td></td>
<td><strong>Toilet &amp; Other Mechanical Ventilation</strong></td>
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<tr>
<td></td>
<td><strong>Site Plan</strong></td>
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<td><strong>HVAC Plant Room</strong></td>
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<tr>
<td>1</td>
<td>Supply</td>
<td>4920</td>
<td>15</td>
<td>73800</td>
<td>25</td>
<td>30750</td>
<td>30000</td>
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<td>15</td>
<td>0</td>
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<td>15</td>
<td>73800</td>
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<td>3</td>
<td>Supply</td>
<td>2582</td>
<td>15</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>8000</td>
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<td>1 x 8000 CFM</td>
<td>MVU Unit</td>
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<td>4</td>
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<td><strong>Pump Room</strong></td>
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</tr>
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<td>Supply</td>
<td>2883</td>
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<td>28830</td>
<td>25</td>
<td>12013</td>
<td>12000</td>
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<td>1 x 12000 CFM</td>
<td>Axial Fan</td>
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<td>5</td>
<td>0</td>
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<td>6</td>
<td>Exhaust</td>
<td>2883</td>
<td>10</td>
<td>28830</td>
<td>25</td>
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<td>12000</td>
<td>Exhaust</td>
<td>1 x 12000 CFM</td>
<td>Axial Fan</td>
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<tr>
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<tr>
<td></td>
<td><strong>Kitchen Near Cafeteria</strong></td>
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</table>
## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
<thead>
<tr>
<th>S/N</th>
<th>Floor</th>
<th>Area SFT</th>
<th>Effective Volumetric CFM</th>
<th>Air Channel</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kw 3/1 Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Supply</td>
<td>365</td>
<td>12 CFM/SFT</td>
<td>4380</td>
<td>5000</td>
<td>Supply</td>
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<td>Air-washer</td>
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<td>3.7</td>
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<td>365</td>
<td>15 CFM/SFT</td>
<td>5475</td>
<td>6000</td>
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### Kitchen

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<th>Effective Volumetric CFM</th>
<th>Air Channel</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kw 3/1 Phase</th>
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</thead>
<tbody>
<tr>
<td>8</td>
<td>Supply</td>
<td>3357</td>
<td>8 CFM/SFT</td>
<td>26856</td>
<td>27000</td>
<td>Supply</td>
<td>1 x 27000</td>
<td>Air-washer</td>
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<td>22</td>
<td>22</td>
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<tr>
<td>9</td>
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<td>3357</td>
<td>15 CFM/SFT</td>
<td>33570</td>
<td>34000</td>
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### Laundry

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<th>Air Channel</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kw 3/1 Phase</th>
</tr>
</thead>
<tbody>
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<td>10</td>
<td>Supply</td>
<td>2195</td>
<td>10 NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Supply</td>
<td>1 x 9000 CFM</td>
<td>Air-washer</td>
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<td>5</td>
<td>5</td>
<td>0</td>
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<tr>
<td>11</td>
<td>Exhaust</td>
<td>2195</td>
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<td>NA</td>
<td>Exhaust</td>
<td>1 x 9000 CFM</td>
<td>Centrifugal</td>
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### Toilet Of Doctor In charge Room & CMO Room

<table>
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<th>Area SFT</th>
<th>Effective Volumetric CFM</th>
<th>Air Channel</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kw 3/1 Phase</th>
</tr>
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<tbody>
<tr>
<td>12</td>
<td>64</td>
<td>8</td>
<td>512</td>
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<td>128</td>
<td>200</td>
<td>Exhaust</td>
<td>2 x 100 CFM</td>
<td>Propeller Fan</td>
<td>2</td>
<td>0.10</td>
<td>0.20</td>
<td>0</td>
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<tr>
<td>13</td>
<td>118</td>
<td>8</td>
<td>944</td>
<td>15</td>
<td>236</td>
<td>200</td>
<td>Exhaust</td>
<td>1 x 200 CFM</td>
<td>Inline Fan</td>
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<td>0.15</td>
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<td>Sterile Store</td>
<td>150</td>
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<td>1200</td>
<td>12</td>
<td>240</td>
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<td>1 x 300 CFM</td>
<td>Propeller Fan</td>
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<td>M &amp; F Toilet Near Emergency Ward (F)</td>
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<td>4480</td>
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<td>Inline Fan</td>
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### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
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<th>Volume CFT</th>
<th>Air Change</th>
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<th>Installed CEM</th>
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<th>Nos. of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw, in Phase 3 / 1</th>
<th>Total Kw</th>
<th>Total Kw</th>
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<td>18</td>
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<td>5856</td>
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<td>1464</td>
<td>1600</td>
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<td>0.74</td>
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<tr>
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<td>U/S Toilet &amp; Store Room</td>
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<td>8</td>
<td>1632</td>
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<td>0.25</td>
<td>0</td>
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<td>12</td>
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<td>700</td>
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<td>2 x 700 CFM</td>
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<td>0.15</td>
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<tr>
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<td>0.37</td>
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<td>15</td>
<td>128</td>
<td>200</td>
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<td>Propeller Fan</td>
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<td>0.20</td>
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<td>344</td>
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<td>Exhaust</td>
<td>1 x 400 CFM</td>
<td>Inline Fan</td>
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**First Floor**

| 27  | 3 Nos. Dirty Utility (Each Area = 140 SFT) | 420 | 8 | 3360 | 15 | 840 | 900 | Exhaust | 3 x 300 | Inline Fan | 3 | 0.25 | 0.75 | 0 | 1 |
## Construction of Medical College & Hospital Sundargarh, Orissa

<table>
<thead>
<tr>
<th>S/N</th>
<th>Floor Description</th>
<th>Floor Area (SFT)</th>
<th>Effective Volme (CFM)</th>
<th>Air Chan</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw, in</th>
<th>Total Kw, in</th>
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<td>0.37</td>
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<td>1 x 400 CFM</td>
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<td>0.25</td>
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<tr>
<td>31</td>
<td>Toilet Of Waiting Area</td>
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<td>344</td>
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<td>86</td>
<td>100</td>
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<td>1 x 100 CFM</td>
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<td>1 x 400 CFM</td>
<td>Inline Fan</td>
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<td>Toilet Of Sample Collection Room</td>
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## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

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<th>Floor</th>
<th>Area SFT</th>
<th>Effective Volume CFM</th>
<th>Air Change</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application CFM</th>
<th>No. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total 3/1 Phase Kw</th>
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<td>39</td>
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<td>8</td>
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<td>15</td>
<td>2192</td>
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<td>2 x 1100 CFM</td>
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### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
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<tr>
<th>S/N</th>
<th>Location</th>
<th>Floor Area (SFT)</th>
<th>Effective Area (SFT)</th>
<th>Exhaust Area (SFT)</th>
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<th>CFM Installed</th>
<th>Application</th>
<th>No. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>in Kw</th>
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<td>x</td>
<td>800 CFM</td>
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<td>128</td>
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<td>Exhaust</td>
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<td>x</td>
<td>100 CFM</td>
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Page 172
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<th>Area (SFT)</th>
<th>Width (ft)</th>
<th>Height (ft)</th>
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<th>Type</th>
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<td>Inline Fan</td>
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<td>2 Nos. Toilet (Each Area = 548 SFT)</td>
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<td>2192</td>
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<tr>
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<td>2 Nos. Linen Store (Each Area = 194 SFT)</td>
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<td>3104</td>
<td>621</td>
<td>800 CFM</td>
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<tr>
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<td></td>
<td>Inline Fan</td>
<td></td>
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</tr>
<tr>
<td>69</td>
<td>2 Nos. Ward Pantry (Each Area = 204 SFT)</td>
<td>408</td>
<td>8</td>
<td>3264</td>
<td>653</td>
<td>800 CFM</td>
<td>2</td>
<td>400</td>
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<td>Inline Fan</td>
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<td>S/N</td>
<td>Floor</td>
<td>Area (SFT)</td>
<td>Effective Area (SFT)</td>
<td>Volume (CFT)</td>
<td>Air Change</td>
<td>Calculated CFM</td>
<td>Installed CFM</td>
<td>Application</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------</td>
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</tr>
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<td>70</td>
<td>8 Nos. Store (Each Area = 635 SFT)</td>
<td>5080</td>
<td>8</td>
<td>40640</td>
<td>12</td>
<td>8128</td>
<td>8000</td>
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<tr>
<td>71</td>
<td>3 Nos. Dirty Utility (Each Area = 160 SFT)</td>
<td>640</td>
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<td>5120</td>
<td>15</td>
<td>1280</td>
<td>900</td>
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<td>72</td>
<td>2 Nos. Store (Each Area = 160 SFT)</td>
<td>320</td>
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<td>12</td>
<td>512</td>
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<td>280</td>
<td>300</td>
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<tr>
<td>74</td>
<td>18 Nos. Toilet Of Doctor Duty, HOD, Nurse Duty, Resident Doctor, Student Duty &amp; Head Of Unit (Each Area = 32 SFT)</td>
<td>576</td>
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<td>4608</td>
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<td>1152</td>
<td>1800</td>
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<td>75</td>
<td>Toilet (M &amp; F) &amp; Pantry</td>
<td>161</td>
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<td>1288</td>
<td>15</td>
<td>322</td>
<td>400</td>
<td>Exhaust</td>
</tr>
<tr>
<td>76</td>
<td>2 Nos. Toilet (Each Area = 548 SFT)</td>
<td>1096</td>
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<td>8768</td>
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<td>2192</td>
<td>2200</td>
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<tr>
<td>77</td>
<td>2 Nos. Ward Pantry (Each Area = 204 SFT)</td>
<td>408</td>
<td>8</td>
<td>3264</td>
<td>12</td>
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<td>78</td>
<td>4 Nos. Dirty Utility (Each Area = 160 SFT)</td>
<td>640</td>
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<td>5120</td>
<td>15</td>
<td>1280</td>
<td>1200</td>
<td>Exhaust</td>
</tr>
</tbody>
</table>

Fifth Floor

4 Nos. Dirty Utility (Each Area = 160 SFT)

640 8 5120 15 1280 1200 Exhaust 4 x 300 Inline Fan 4 0.25 1.00 0 1
<table>
<thead>
<tr>
<th>S/N</th>
<th>Floor Description</th>
<th>Area (SFT)</th>
<th>Effective Volume (SFT)</th>
<th>Exhaust Volume (CFM)</th>
<th>Air Change Rate (Air/HR)</th>
<th>Calculated Exhaust Volume (CFM)</th>
<th>Inst. CFM</th>
<th>Application No.</th>
<th>Rated Kw of Fan (Each)</th>
<th>Total Kw of Fan</th>
<th>No. of Point</th>
<th>Type of Fan</th>
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<tbody>
<tr>
<td>79</td>
<td>Soiled Linen Room</td>
<td>290</td>
<td>8</td>
<td>2320</td>
<td>12</td>
<td>464</td>
<td>500</td>
<td>Exhaust</td>
<td>1 x 500 CFM</td>
<td></td>
<td>1</td>
<td>Inline Fan</td>
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<tr>
<td>80</td>
<td>Toilet Near TSSU</td>
<td>43</td>
<td>8</td>
<td>344</td>
<td>15</td>
<td>86</td>
<td>100</td>
<td>Exhaust</td>
<td>1 x 100 CFM</td>
<td></td>
<td>1</td>
<td>Inline Fan</td>
</tr>
<tr>
<td>81</td>
<td>Toilet Of Post Operative Recovery &amp; Pre Anesthetic Room (Each Area =43 SFT)</td>
<td>86</td>
<td>8</td>
<td>688</td>
<td>15</td>
<td>172</td>
<td>200</td>
<td>Exhaust</td>
<td>2 x 100 CFM</td>
<td></td>
<td>2</td>
<td>Propeller Fan</td>
</tr>
<tr>
<td>82</td>
<td>12 Nos. Toilet Of Doctor Duty, Surgeon Room, HOD, Nurse Duty, Resident Doctor, Student Duty, Head Of Unit &amp; CSSD Manager (Each Area = 32 SFT)</td>
<td>384</td>
<td>8</td>
<td>3072</td>
<td>15</td>
<td>768</td>
<td>1200</td>
<td>Exhaust</td>
<td>12 x 100 CFM</td>
<td></td>
<td>12</td>
<td>Propeller Fan</td>
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<tr>
<td>83</td>
<td>Toilet (M &amp; F) &amp; Pantry</td>
<td>161</td>
<td>8</td>
<td>1288</td>
<td>15</td>
<td>322</td>
<td>400</td>
<td>Exhaust</td>
<td>1 x 400 CFM</td>
<td></td>
<td>1</td>
<td>Inline Fan</td>
</tr>
<tr>
<td>84</td>
<td>Toilet Near Ward</td>
<td>548</td>
<td>8</td>
<td>4384</td>
<td>15</td>
<td>1096</td>
<td>1100</td>
<td>Exhaust</td>
<td>1 x 1100 CFM</td>
<td></td>
<td>1</td>
<td>Inline Fan</td>
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<tr>
<td>85</td>
<td>Ward Pantry</td>
<td>204</td>
<td>8</td>
<td>1632</td>
<td>12</td>
<td>326</td>
<td>400</td>
<td>Exhaust</td>
<td>1 x 400 CFM</td>
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<td>1</td>
<td>Inline Fan</td>
</tr>
<tr>
<td>86</td>
<td>Sterile Store</td>
<td>1098</td>
<td>8</td>
<td>8784</td>
<td>12</td>
<td>1757</td>
<td>1800</td>
<td>Exhaust</td>
<td>1 x 300 CFM</td>
<td></td>
<td>1</td>
<td>Propeller Fan</td>
</tr>
</tbody>
</table>

**Lift Well, Staircase Pressurization**

| S/N | Lift Well - 8 Nos. | NA | NA | NA | NA | NA | NA | Supply | 8 x 10000 CFM | Axial Fan | 8 | 3.70 | 0 | 29.6 | 3 |
## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

### Smoke Extraction

| S/N | Description | Area | Effect | Volume | Calculation | Exh. Vol | Calculation | CFT | No. of Fan | Type of Fan | No. of Point | Kw of Each | Total Kw | Total Kwh | Total Kwh |
|-----|-------------|------|--------|--------|------------|----------|------------|-----|-----------|-------------|-------------|------------|-----------|----------|----------|----------|
| 88  | Staircase - 7 Nos | NA | NA | NA | NA | Supply | 7 x 12000 CFM | Axial Fan | 7 | 5.50 | 0 | 38.5 | 3 |
| 89  | Lift Lobby - 4 Nos | NA | NA | NA | NA | Supply | 4 x 10000 CFM | Axial Fan | 4 | 5.50 | 0 | 22.0 | 3 |

### Fresh Air (Upper Floors Escape Route)

<table>
<thead>
<tr>
<th>S/N</th>
<th>Description</th>
<th>Area</th>
<th>Effect</th>
<th>Volume</th>
<th>Calculation</th>
<th>Exh. Vol</th>
<th>Calculation</th>
<th>CFT</th>
<th>No. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kwh</th>
<th>Total Kwh</th>
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</thead>
<tbody>
<tr>
<td>90</td>
<td>Fresh Air (Upper Floors Escape Route)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Supply</td>
<td>22 x 3000 + 2 x 5000 + 2 x 15000 CFM</td>
<td>Axial Fan</td>
<td>28</td>
<td>3.7 + 5.5</td>
<td>0</td>
<td>107.0</td>
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</table>

### Exhaust Air (Upper Floors Escape Route)

<table>
<thead>
<tr>
<th>S/N</th>
<th>Description</th>
<th>Area</th>
<th>Effect</th>
<th>Volume</th>
<th>Calculation</th>
<th>Exh. Vol</th>
<th>Calculation</th>
<th>CFT</th>
<th>No. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kwh</th>
<th>Total Kwh</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>Exhaust Air (Upper Floors Escape Route)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Supply</td>
<td>32 x 3000 + 2 x 5000 CFM</td>
<td>Axial Fan</td>
<td>34</td>
<td>3.7</td>
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<td>125.8</td>
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</table>

### Medical College

#### Ground Floor

<table>
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<th>S/N</th>
<th>Description</th>
<th>Area</th>
<th>Effect</th>
<th>Volume</th>
<th>Calculation</th>
<th>Exh. Vol</th>
<th>Calculation</th>
<th>CFT</th>
<th>No. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw</th>
<th>Total Kwh</th>
<th>Total Kwh</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>Toilet Of Girls &amp; Boys (Each Area = 473 SFT)</td>
<td>946</td>
<td>8</td>
<td>7568</td>
<td>15</td>
<td>1892</td>
<td>2000</td>
<td>Exhaust</td>
<td>2 x 1000 CFM</td>
<td>Inline Fan</td>
<td>2</td>
<td>0.60</td>
<td>1.20</td>
<td>0</td>
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<tr>
<td>93</td>
<td>Record Room Near Central Photographic Section</td>
<td>807</td>
<td>8</td>
<td>6456</td>
<td>12</td>
<td>1291</td>
<td>1300</td>
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<td>1 x 1300 CFM</td>
<td>Inline Fan</td>
<td>1</td>
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<td>0.60</td>
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<tr>
<td>94</td>
<td>Cooking Area Near Cafeteria</td>
<td>408</td>
<td>12 CFM/SFT</td>
<td>4896</td>
<td>5000</td>
<td>Supply</td>
<td>1 x 5000</td>
<td>Air-washer</td>
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<td>408</td>
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<td>6000</td>
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<td>3.7</td>
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<tr>
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<td>Height</td>
<td>Length</td>
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<td>Fan Type</td>
<td>Speed</td>
<td>Pressure</td>
<td>Volume</td>
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<td>Toilet (M &amp; F) Near Meeting Room</td>
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<td>22</td>
<td>8</td>
<td>176</td>
<td>15</td>
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<td>Propeller Fan</td>
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<td><strong>First Floor</strong></td>
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</tr>
<tr>
<td>99</td>
<td>Toilet Of Girls &amp; Boys(Each Area = 473 SFT)</td>
<td>946</td>
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<td>7568</td>
<td>15</td>
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<td>2000</td>
<td>2 x</td>
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</tr>
<tr>
<td>101</td>
<td>2 Nos. Toilet (M &amp; F) &amp; Pantry</td>
<td>280</td>
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<td>2240</td>
<td>15</td>
<td>560</td>
<td>600</td>
<td>2 x</td>
<td>300</td>
<td>0.25</td>
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<td>102</td>
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<td>86</td>
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<td>688</td>
<td>15</td>
<td>172</td>
<td>200</td>
<td>2 x</td>
<td>100</td>
<td>0.10</td>
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<td>Exhaust Fan</td>
<td>Propeller Fan</td>
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</tr>
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<td><strong>Second Floor</strong></td>
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</tr>
<tr>
<td>102</td>
<td>Toilet Of Girls &amp; Boys(Each Area = 473 SFT)</td>
<td>946</td>
<td>8</td>
<td>7568</td>
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<td>1000</td>
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<td>Propeller Fan</td>
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<td></td>
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</tr>
<tr>
<td>103</td>
<td>2 Nos. Toilet (M &amp; F) &amp; Pantry</td>
<td>280</td>
<td>8</td>
<td>2240</td>
<td>15</td>
<td>560</td>
<td>600</td>
<td>2 x</td>
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<td>Propeller Fan</td>
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<td>105</td>
<td>2 Nos. Toilet Of Girls &amp; Boys(Each Area = 473 SFT)</td>
<td>946</td>
<td>8</td>
<td>7568</td>
<td>15</td>
<td>1892</td>
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## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

<table>
<thead>
<tr>
<th>S/N</th>
<th>Floor</th>
<th>Area SFT</th>
<th>Effective</th>
<th>Volume SFT</th>
<th>Air Change</th>
<th>Calculated CFM</th>
<th>Installed CFM</th>
<th>Application</th>
<th>Nos. of Fan</th>
<th>Type of Fan</th>
<th>No. of Point</th>
<th>Kw of Each</th>
<th>Total Kw.</th>
<th>Total Kw. in 3 / 1 Phase</th>
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<td>8</td>
<td>688</td>
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<td>1892</td>
<td>2000</td>
<td>Exhaust</td>
<td>2 x 1000 CFM</td>
<td>Inline Fan</td>
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<td>15</td>
<td>280</td>
<td>300</td>
<td>Exhaust</td>
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<td>1 x 100 CFM</td>
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<td>187.9</td>
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ii) Design Parameters

A) For Water-cooled Rotary Screw Water Chilling Machine

a) Temperature of chilled water entering the chillers °C : 12.22
b) Temperature of chilled water leaving the chillers °C : 6.67
c) Chilled water flow rate US GPM / TR : 2.4
d) Fouling factor of chillers (MKS) : 0.0001
e) Temperature of water to inlet of condenser °C : 32.77
f) Temperature of water leaving the condenser °C : 36.94
g) Condenser water flow rate US GPM / TR : 4.0
h) Fouling factor of Condenser MKS : 0.0002
i) Maximum water velocity MPS : 2.5

B) Piping Work

a) Friction loss (Maxm.) Mt / 100 Mt lengths : 5.0
b) Flow velocity (Maxm.) Mt / Sec. : 2.50

C) Air-handlers

a) Maximum Face velocity across cooling coil MPM : 152.0
b) Maximum face velocity across pre/fine/hepa filters/ Heat Recovery Wheel in MPM : 152.0
c) Maximum water pressure drop across the coil in Mt. : 4.6
d) Maximum water velocity through coil in MPS : 2.5
e) Maximum Fan outlet velocity MPS : 10.0

D) Ducting Work

a) Method of Duct Design : Equal friction Method
b) Maximum air velocity in supply duct (AC) MPM : 550.0
c) Maximum air velocity in return duct (AC) MPM : 457.0
d) Friction loss in duct (Maxm.) MM Wg in 100 Mt run. : 8.33
e) Maximum Velocity at supply air grill outlet (AC) MPM : 150.00

iii) System Description

Selection of Chillers
Total Worked Out AC Load with Diversity of 80% = 689 TR

Water Cooled Rotary Screw Chiller of Actual Capacity 350.0 TR (2W+1S)

Scheme for Air Conditioning System

It is proposed to install water cooled 3 x 350 TR (2W+1S) Rotary Screw Chiller of actual capacity on 415 V to cater to the above refrigeration load.

These Water chilling machines shall work in conjunction with 3 Nos. Primary Chilled Water Pump Sets (one as standby), 3 Nos. Condenser Water Pump Sets (one as standby), 06 Nos. Secondary Chilled Water Pump Sets (Three as standby), 3 Nos. Cooling Towers, 2 Nos. Hot Water Generator (1W+1S) for Monsoon Reheat, Main Electrical Panel, Sub Panel, BMS for HVAC Work etc.

The above mentioned high side system shall work in conjunction with double skinned AHUs, MS C class chilled & Hot water piping with fittings and valves duly insulated, MS C class condenser water piping with fittings and valves etc.

Each zone shall have dedicated double skinned AHU / FCU of required capacity. Low side work such as ducting, grilles / diffusers, insulation, duct lining etc. as shown in the drawings have been quantified in the BOQ & it shall be installed & commissioned by the AC contractor.

Electrical work shall comprise of main panel, sub-panels for air-handling units & fan, power & control cabling with earthing etc.

Chilled water piping from the AC plant room shall be connected through chilled water risers to various AHUs / FCUs. Chilled water tapping for AHU / FCU on various levels shall be taken from the risers.

The complete air-conditioning system shall have one point control through BMS & is part of the HVAC package.

Scheme for Ventilation of Toilets

For all the toilets, inline fan of required capacity shall be installed in the ceiling of individual toilet. Foul smell collected in the duct from the toilet on each floor shall be connected with the inline fan. Foul smell from the toilet shall be trapped with the help of diffusers / grilles and it shall be carried forward to duct.

Scheme for Ventilation of Kitchen

It is proposed to install suitable capacity Air-washer & scrubber for kitchen ventilation. The air shall be distributed with the help of GSS ducting & diffused through powder coated Aluminium extruded grills. The air shall be exhausted through suitable capacity exhaust air duct terminating into scrubber.

NOTE:

The Centrifugal Fan & Scrubber shall be selected as per final layout & requirements however fan capacity is given in the BOQ for guideline.

Scheme for Lift Well, Fire Escape Staircase & Lobby Pressurisation

It is proposed to install required number of tube axial flow fans of required capacity on the terrace to pressurize lift well / fire escape staircase. In the lift well air shall be directly fed through axial flow fan connected to a small piece of duct. For the fire escape staircase, duct
dropper in the shaft shall be taken up to the last basement and individual collar for supply to each level shall be connected with the duct dropper.

All lift well and fire escape staircase shall have a positive pressure of 50 Pa compared to the surrounding areas. All pressurization fans shall run in case of fire only. Panel of pressurization fan shall be hooked with the fire alarm panel.

B)  TECHNICAL SPECIFICATION OF EQUIPMENTS

i)  Water Cooled Rotary Screw Water Chilling Machine
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

i. Scope of Work

The specification for chilling machine covers the general design, materials, constructional features, supply, installation, testing, commissioning & carrying out performance test at site.

ii. Codes & Standards

The design, materials, manufacture, inspection, testing & performance of Water Cooled Rotary Screw chilling machine shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed. Following codes & standards (Not Limited To) shall be followed:

ARI 575 - Air Conditioning and Refrigeration Institute. Standard Method of Measuring Machinry Sound Within Equipment Rooms (Basis of all data presented or field testing of equipment, with relation to sound requirements).
ASME CODE - American Society of Mechanical Engineers. Code for Unfired Pressure Vessels - Section VIII (Design, construction, testing and certification of pressure vessels).
ANSI-B31.5 - American National Standards Institute. Code for Refrigerant Piping
TEMA - Tubular Exchanger Manufacturer’s Association
ISO R281 - Rolling Bearings – Dynamic Load Ratings and Rating Life

iii. Chiller Design Duty

a) Water Chilling Unit shall be of rotary screw type & shall produce actual refrigeration capacity of 350 TR, cooling 840 US GPM of chilled water from 54.0 to 44.0 °F when supplied with 1400 US GPM of condenser water at 91°F. The bidder shall submit performance characteristics of chillers for both specified conditions as above and at ARI conditions.

b) The bidder shall submit printout of computerized selection of chillers duly stamped and signed by authorized representative of the chiller manufacturer from factory along with the tender.

c) The cooler shall be selected for 0.00050 (fps units) fouling factor. Water side shall be designed for minimum 150 psig working pressure. The condenser shall be selected for 0.00100 (fps units) fouling factor. Water side shall be designed for minimum 150 psig working pressure.

d) Power shall be supplied to the chiller at 415 volts – 3 phase - 50 Hertz. The chiller shall use R-134a refrigerant.

e) The cooling capacity specified shall be the net cooling capacity of the chiller produced excluding the cooling requirement for the motor heat rejection. The chiller efficiency shall be calculated based on the net chiller capacity (excluding the cooling capacity required for motor cooling) and the total chiller input power plus any additional power required for the motor cooling.
iv. **Screw Compressor**

The Rotary Screw Water chilling machine shall consist of multiple Mono / Twin, Horizontal / Vertical, Hermetic / Semi-hermetic / Open, Direct driven low speed helical rotary compressors, refrigerant / air cooled motor, oil separator, evaporator, condenser, factory mounted microprocessor based panel, interconnecting refrigerant piping, electronic expansion valve, controls and accessories to make it compact & efficient unit. The capacity control shall be achieved by use of slide valve to provide fully modulating control from 100 % to 20 % of the full load. The cost of starter is to be included in the cost of unit.

v. **Microprocessor Control Panel**

Factory mounted microprocessor-based control panel must be provided with at least the following features:

1. Automatic shutdown protection with manual reset for
   a) Low evaporator refrigerant temperature and pressure,
   b) High condenser refrigerant pressure,
   c) Loss of condenser water flow,
   d) High motor temperature,
   e) Low oil flow,
   f) Electrical distribution faults such as Phase reversal, phase loss, Phase imbalance, motor current overload,
   g) High compressor discharge temperature.

2. Critical sensor or detection of circuit fault in
   a) Starter transition failure.
   b) External or local emergency stop.

3) Automatic shutdown protection with automatic reset when condition is corrected for loss of chilled water and condenser water flow, high compressor discharge temperature, under / over voltage and momentary power loss.

The monitoring system should be provided for early detection and warning of refrigerant loss. Microprocessor based chilled water reset based on return water is necessary & must be provided.

The unit control panel should be capable of avoiding unit shutdown due to transient abnormal operating conditions associated with low evaporator refrigerant temperature, high condensing temperature and motor current overload. If the abnormal operating condition persists and the protective limit is reached, the machine will be shut down. The microprocessor-based panel should be compatible to building management system & the chiller shall have interface card.

vi. **Evaporator**

Evaporator will be of the shell-and-tube, flooded type designed for 180 psig working pressure on the refrigerant side and 150 psig on waterside. The heat exchanger shall be hydrostatically tested at 1.5 times the design pressure. Shell will be fabricated from minimum 10 mm thick rolled carbon steel plates with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with applicable Pressure Vessel Code.

Tubes shall be copper of 19 mm dia O.D. and minimum 0.71 mm wall thickness high efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 12 fps. Two liquid level sight glasses will be located on the side of the shell to aid in determining proper refrigerant charge. Aluminium mesh eliminators will be located above the tube
bundle to prevent liquid refrigerant carryover to the compressor. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration.

The Evaporator shall be horizontal, shell and tube type, provided with the following connections and accessories.

i. Refrigerant inlet and outlet pressure gauges.
ii. Water inlet and outlet connections.
iii. Drain and vent connections with stop valves.
iv. Pressure gauges & transducers / Temperature gauges & thermisters on water inlet and outlet connections.
v. Descaling valves.

Evaporator shall be factory insulated with multi layer 75 mm thick/or equivalent thermal insulation as per manufacturers standard with vapor barrier, thermal insulation material. The insulation shall be set in hot asphalt or any other compound applied to 100% of insulation contact surface recommended by the insulation manufacturer and shall be applied in layers staggering and sealing the joints.

vii. Condenser

The condenser shells shall be of rolled carbon steel plate with fusion welded seams. Removable compact water boxes of cast iron or welded steel with stub-out water connections shall be provided to permit access for tube cleaning and replacement. The tubes shall be finned from outside having spiral ridges from inside, roller expanded into the tube sheets providing a leak proof seal. The tube material will be copper. Intermediate steel tube supports should be provided at intervals not exceeding 1200 mm. Two sets of electrical rotary shaft type tube cleaners shall be provided for cleaning of condenser tubes.

The condenser shall be horizontal, shell and tube type. The condenser shall be complete with the following accessories:

i. Refrigerant inlet and outlet pressure gauges.
ii. Water inlet and outlet connections.
iii. Drain and vent connections with stop valves.
iv. Pressure gauges & pressure transducers, and temperature gauges & Thermisters on water inlet and outlet connections.
v. Descaling valves.

viii. Installation

The chilling machine shall be installed over a cement concrete platform and shall be adequately isolated as per manufacturer’s recommendations against transmission of vibrations to the building structure by use of spring packages. 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 Contractor or his authorised representatives, using a dial indicator. Compressor and motor sole plates, anchor bolts and sleeves and necessary vibration isolation pads shall be included.

ix. Painting

Screw water chilling machine shall be finished with durable epoxy/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.

x. 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. Power consumption of chillers shall be maximum 0.68 KW / TR (At Given Condition) at 100% load & COP shall be minimum 6.2 when tested according to ARI 550/590-1998. The chiller capacity shall be 350 TR at given condition in BOQ & not at ARI Condition.

xi. Performance Testing

Prior to shipment, chilling machines shall be subjected to inspection and witness of performance tests by Department or his authorized representative / Consultant / Architect to verify various performance parameters as confirmed by contractor earlier at the time of award of contract. The contractor shall quote separately including the charges for all stage wise inspection(s) and performance testing(s). The charges shall also include airfare, boarding & lodging of a maximum of three persons of Department or his representative / Consultant / Architect for each of the inspection(s) and performance testing(s).

One chiller of each type / capacity shall be factory Performance tested in the presence of Department or his representative / Consultant / Architect:

- Under simulated conditions of design parameters at full load (100%) & at 3 part load points (75%, 50%, 25%) at constant condenser water entering temperature of 90 deg F in an Euro vent/ARI-accredited test facility.

The manufacturer shall supply certified test reports to confirm performance as specified. The manufacturer shall provide proper ARI/Eurovent certification documents for the test bed with submittals for inspection. The performance test shall be conducted in accordance with ARI Standard 550/590-98 / Eurovent procedures and tolerances.

The equipment will be accepted if the test procedures and result are in conformance with Eurovent/ARI standard 550/590-98. If the equipment fails to perform within the allowable tolerances, the manufacturer will be allowed to make one revision to his equipments and retest as required. The contractor shall pay all associated expenses resulting from retesting. In the event that this revision does not achieve submitted performance, Employer reserves the right to reject the equipment or accept with a penalty.

The contractor shall pay a penalty to Department of Rs. 5,00,000/- per chiller for excess of each input KW at full load or NPLV as compared to his tender submission and input KW measured during testing carried out at manufacturer’s work as per ARI condition or/and tender design condition. The Department reserves the right to accept Chillers after recovery of penalty for all chillers whether tested at works or not.
ii) Cooling Tower

i. Scope of Work

This specification covers the design requirement, materials, constructional feature, manufacture & supply, installation, testing, commissioning of FRP Cooling Towers.

ii. 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 ASHRAE 90.1-2004 performance standards.

iii. Types & Capacity of Cooling Tower

The cooling tower shall be induced draft, cross / counter flow type conforming to their respective specification & of rectangular / square profile. Each cooling tower actual capacity shall be as specified in BOQ.

iv. Constructional Feature of Cooling Tower

The induced draft cross / counter 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. 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 propeller fan of the cooling tower shall be direct driven by TEFC squirrel cage motor located 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 0.02% 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.

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) Ball type automatic make-up water valve.
vi) Equalizing connection & balancing valves for multiple CTs as required.
vii) Quick Fill arrangements

**Mechanical Equipment**

The cooling tower shall be provided with low speed, low noise, and acoustically treated fans running at lower RPM through direct driven motor. Fan speed shall not be more than 750 RPM. Fan shall be of the propeller type lightweight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be statically and dynamically balanced. Fan shall be driven by TEFC 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.

**Fillings:**

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.

**Distribution Header**

Hot water distribution system shall comprise of header and branch arms system.

v. **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 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 Hardware used shall be of stainless steel. All pipe connections shall be hot dip galvanized and double flanged.

vi. **Painting**

All exposed steel surfaces shall be given two coats of epoxy paint & the colour finish of cooling tower shall as per Architect’s decision.

vii. **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 38.2 GPM/HP when tested according CTI ATC-105 procedure.

viii. **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.
iii) Pumps

i. Scope Of Work

This section deals with supply, erection, testing and commissioning of water Vertical Inline Pumps conforming to general specification and suitable for the duty selected as indicated in Technical Requirement of Equipment. The type, capacity and size of pumps shall suit the parameters given under. The Pumps selected should have high efficiency, which should be supported by selection charts and curves.

ii. Vertical Inline Pumps Sets

Vertical Inline Centrifugal Pump shall be selected for chilled / hot / condenser water re-circulation duty. The pump casing shall have heavily ribbed construction, suction and discharge connection shall be flanged of the same size and shall be drilled and tapped for seal flush and gauge. The impeller made of bronze shall be double shrouded, single entry, radial flow type. It shall be hydraulically balanced to minimize axial thrust. The stuffing box shall be factory fitted with mechanical seal.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner.

The axially split, spacer type rigid coupling shall be used to allow seal maintenance without disturbing the pump or motor connections. The mechanical seal shall be accessible and easily replaced.

On the discharge side of each pump factory supplied- combination Valve shall be provided to incorporate the following three functions in one body:

- Tight shut-off,
- spring-closure type silent non-slam check and
- effective throttling.

The body shall have (2) 1/4” NPT connections on each side of the valve seat. Two connections to have brass pressure and temperature metering ports, with EPDM check valves and gasketed caps. Two other connections to be supplied with drain plugs. Metering ports are to be interchangeable with drain ports to allow for measurement flexibility when installed in tight locations. The valve disc shall be bronze plug & disc type with EPDM seat to ensure tight shut-off and silent check operation. The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.

For Grooved Piping: Valve body shall be ductile iron with grooved ends and anti-rotation lugs on the inlet and outlet of the body. Flange adapters, where necessary are to be ductile iron flanges with anti-rotation lugs and EPT gaskets. Valve body shall be Cast Iron with PN16 flanged ports.

The valve shall be selected and installed in accordance with the manufacturer’s instructions and be suitable for the pressure and temperature specified.

On the suction of each pump factory supplied suction guide, with Outlet Flow Stabilizing Guide Vanes, removable Stainless Steel Strainer and Fine Mesh Start-up Strainer shall be provided. Supply suction guide with carbon steel body, carbon steel guide vanes and PN16 flanged ports. Strainer element shall be stainless steel construction with 0.125"(3 mm) perforations. Fine mesh start-up strainer shall be 20 mesh galvanized steel. The mechanical contractor shall inspect the strainer prior to activating the pump and, further, shall remove the Fine Mesh Start-up Strainer after a short running period. (24 hours maximum). Space shall be provided for removal of the strainer and connection of a Blow-down Valve.

The construction of Vertical Inline Pumps shall be as follows and as per IS 1520
Duty: Chilled / Hot / Condenser Water
Casing: Cast Iron
Impeller: Bronze
Pump Shaft: Stainless Steel Grade 416
Bearings: Ball / Journal Bearing
Speed (Synchronous): 1500 RPM
Motor: TEFC
Mechanical seal: Factory fitted

The impellers of pumps shall be statically and dynamically balanced.

iii. Motor Capacity

The capacity of motor shall be 10% in excess of BHP requirement of pump & shall be as per Standard Specifications. The tenderer shall provide detailed calculation for selection of pumps.

The contractor as per manufacturer recommendations shall carry out the installation of pumps. After installation of the complete system and before testing, the pump shall be lubricated in strict accordance with the manufacturer’s instructions. The pumps shall be installed in a manner that would allow maintenance without causing damage to the insulation.

After completion of installation and testing, the pumps shall be painted as specified in tender document.

iv) Variable Speed Pumping System

i. Scope of Work

This section deals with supply, erection, testing and commissioning of variable speed pumping system for chilled water conforming to general specification and suitable for the duty selected as indicated in Technical Requirement of Equipment. The type, capacity and size of pumps shall suit the parameters given under. The Pumps selected should have high efficiency, which should be supported by selection charts and curves. This package shall consist of the following:

1. Pump, Motor, Base Frame, Coupling
2. Pump Control Panel
3. Adjustable Frequency Drive
4. Sensor Transmitters
5. Sequence of Operation
6. Connection drawings and wiring diagrams to be supplied with the pumping package.

ii. References

ANSI - American National Standards Institute
NEMA - National Electrical Manufacturers Association
UL - Underwriters Laboratories Inc.
ETL - Electrical Testing Laboratories
CSA - Canadian Standards Association
NEC - National Electrical Code
ISO - International Standards Organization
IEC - International Electro technical Commission

iii. Submittals

Submittals shall include the following related to this project only & not general:

1. System summary sheet
2. Sequence of operation
3. Shop drawing indicating dimensions, required clearances and location and size of each field connection
4. Power and control wiring diagrams
5. System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and AFD efficiencies, job specific load profile, staging points, horsepower and kilowatt/hour consumption.
6. Pump data sheets

iv. Quality Assurance

1. The pump manufacturer shall assemble the pumping package. 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.

2. The manufacturer shall have a minimum of 20 years experience in the design and construction of variable speed pumping systems.

3. The local supplier of Chilled Water Variable Speed Pumping System (VSPS) Must have relevant expertise in all aspects of design, application engineering, Installation, programming, interfacing, commissioning and after sales service.

4. The manufacturer shall be fully certified by the International Standards Organization per ISO 9001. Proof of this certification shall be furnished at time of submittal.

5. Manufacturer shall be listed by Underwriter's Laboratories as a manufacturer of packaged pumping systems.

6. Bidders shall comply with all sections of this specification relating to packaged pumping systems. Any deviations from this specification shall be bid as a voluntary alternate clearly defined in writing. If no exceptions are noted, the supplier or contractor shall be bound by these specifications.

v. Manufactured Units

1. Furnish and install as shown on the plans a Variable Speed Pumping System as manufactured by approved make.

2. The control system shall include as, a minimum, the programmable logic pump controller, adjustable frequency drive(s) and remote sensor/transmitters as indicated on the plans. Additional items as specified or as required to properly execute the sequence of operation shall be supplied & installed.

3. The variable speed pump logic controller, adjustable frequency drive(s) and remote sensor/transmitter(s) shall ship as individual components to the jobsite.

4. Pump logic controller, adjustable frequency drives, sensor/transmitters and related equipment shall be installed by the AC contractor as shown on the plans.

5. Line voltage power wiring shall be installed by the electrical expert hired by the AC contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.
6. Low voltage (24 VDC and 115 VAC) wiring shall be installed by the controls expert hired by the AC contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

vi. Components

A) Pump Logic Controller

1. The pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory, Inc. (UL). The controller shall be specifically designed for variable speed pumping applications. Pump Logic Controller shall be suitably interfaced with one Adjustable Frequency Drive housed within same enclosure.

2. The controller shall function to a proven program that safeguard against damaging hydraulic conditions including:
   a) Pump flow surges
   b) Hunting
   c) End of curve
   d) Motor overload

3. 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 set point. This selected signal will 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 up to three pumps in parallel.

4. The pump logic controller shall be capable of accepting an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.

5. 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.

6. The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:
   a. Multi-fault memory and recall last 10 faults and related operational data.
   b. Red fault light, yellow warning light, and Green power on light
   c. Soft-touch membrane keypad switches.

7. 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.

8. The following communication features shall be provided to the BAS:
   a. Remote system starts / stops non-powered digital input.
   b. Failure of any system component. Output closes to indicate alarm condition.
   c. One 4-20 mA output with selectable output of:
      1. Frequency.
      2. Process variable
      3. Output current
      4. Output Power
B) Variable Frequency Drive

1. The variable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design.

2. The VFD, including all factory-installed options, be tested to UL Standard 508. The VFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.

3. The VFD shall be housed in a NEMA 1 IP 55 enclosure.

4. The VFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no de-rating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life. Power factor shall be near unity regardless of speed or load.

5. The VFD shall have balanced DC link reactors to minimize power line harmonics. VFD’s without a DC link reactor shall provide a 3% impedance line reactor.

6. Automatic motor adaptation (AMA) algorithm shall be utilized. This feature shall allow for automatically optimized drive performance and efficiency leading to additional energy savings.

7. Input and output power circuit switching can be done without interlocks or damage to the VFD.

8. The following customer modifiable adjustments shall be provided:
   a. Acceleration time.
   b. Deceleration time.
   c. Minimum frequency.
   d. Maximum frequency.

9. RS-485 communication for Johnson Controls N2 and Landis and Staefa FLN.

10. An automatic energy optimization selection feature shall be provided. This feature shall reduce voltages when lightly loaded and provide a 3% to 10% additional energy savings.

11. The VFD shall be suitable for elevations to 3300 feet above sea level without de-rating. Maximum operating ambient temperature shall not be less than 110 degrees F. VFD shall be suitable for operation in environments up to 95% non-condensing humidity.

12. The VFD shall be capable of displaying the following information in plain English via a 40 character alphanumeric display:
   a. Frequency
   b. Voltage
   c. Current
   d. Kilowatts per hour
   e. Fault identification
   f. Percent torque
   g. Percent power
   h. RPM

C) Sensor / Transmitters

Provide field mounted differential pressure sensor transmitter(s) as indicated 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 stainless steel wetted parts with two 0.25” male NPT process connections. It shall be protected against radio frequency interference and shall have a watertight, NEMA 4 electrical enclosure capable of withstanding 2000 PSI static pressure with a 0.5” NPT conduit connection. Accuracy shall be within 0.25% of full span.

Minimum two numbers of differential pressure sensors located at strategic location with substantial flow demand or remoteness at each zone served by secondary pumping shall be provided.

D) Sequence of Operation

1. The system shall consist of a pump logic controller, multiple pump/VFD sets, with manual and automatic alternation and pump staging.

2. 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.

3. When the pump logic controller selector switch is in the LOCAL position, and start command on controller is given via operator interface, the pumping system shall operate automatically.

4. Sensor/transmitters shall be provided as indicated on the plans.

5. Each sensor/transmitter shall send a 4-20mA signal to the pump logic controller, indicative of process variable condition.

6. The pump logic controller shall compare each signal to the independent, engineer/user determined set points.

7. When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.

8. The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

9. If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump.

10. The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.

11. Further change in process variable shall cause the pumps to change speed together.

12. When the set point criteria can be safely satisfied with fewer pumps, the Technologic pump logic controller shall initiate a timed de-stage sequence and continues variable speed operation [wherever applicable].

13. 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.

14. In the event of an VFD 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.

15. Upon VFD fault(s), the pump controller shall display an alarm condition through a plain English message.
16. VFD 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.

17. 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.

18. Upon sensor failure a plain English warning message shall be displayed on the operator interface of the pump logic controller.

19. In the event of failure to receive all zone process variable signals, a user selectable number of VFDs shall maintain a user adjustable speed; reset shall be automatic upon correction of the zone failure.

v) Double Skinned Air Handling Unit

i. Scope of Work

The specification for Double Skin Air Handling Units covers the design requirement, constructional feature, supply, installation, testing & commissioning. The floor mounted horizontal / vertical type & ceiling suspended type air handlers shall be of double skin construction, draw through type comprising of various sections such as pre filter section, cooling coil section, fan section for floor mounted AHU etc as per details given in BOQ.

ii. Double Skinned Air Handling Units

a) Double Skinned Casing

The casing shall be self supporting type, factory fabricated & assembled made of extruded anodised aluminum hollow sections to make a rigid frame structure. The frame shall be assembled using pressure die cast aluminum joints. The self supporting unit shall consist of sandwiched panel made out of 0.6mm thick pre-plasticide / pre-coated GI sheet outside & 0.6mm GI sheet inside (0.6 mm polished stainless steel in case of AHU for Operation Theatre) duly factory fabricated insulated with 23 / 48 mm thick PU foam insulation in between as specified in Bill of Quantities. The insulated panels shall be bolted to mainframe with neoprene rubber gaskets held captive in the framed extrusion to make it leak proof. Suitable airtight access doors / panels with pressure die cast aluminum hinges & nylon handles 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 joiners or the framework shall be joined together with corner plates Condensate. Drain Pan shall be constructed of 22 gauge Stainless steel sheet with all corners welded with uniform slope from all sides leading to drain pan ensuring no stagnation of condensate water.

b) Motor & Drive

The fan motors shall be suitable for 415 ± 10% volts, 50 ± 5 % HZ, 3 phases TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement. Belts shall be of oil resistant type only.

c) Fan of Double Skinned Air Handling Units

The casing shall have heavy gauge GI construction forward curved DIDW imported fan statically & dynamically balanced mounted on EN8 solid shaft or C 40 carbon steel. The supply air DIDW fan shall be forward / backward curved as per BOQ. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The
fan shall be selected for a fan outlet velocity below 10 meter / sec. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators in case the impeller diameter is exceeding 450 mm & rubber turret mounts vibration isolators for fan diameter up to 450mm diameter. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

d) Cooling / Heating Coils

The cooling & heating coil shall be made of aluminum fins and copper tubes of dia.12.5mm or 16mm OD. The minimum no. of fins / cm for cooling coils shall be 4.7 & for heating coil it shall be 2.4. The bonding of aluminum fins with copper should be done hydraulically. The tube thickness shall be 26 G & fin thickness shall be 37 G. The cooling / heating coil should be tested for leaks at a hydraulic pressure of at least 10 Kg / sq.cm. for a minimum period of 3 hours at works. The velocity across face should be limited to 152 metre / minute. In case of chilled / hot water coils the design should be such to limit water velocity to maximum of 2.5 m / sec.

e) Filters

Each unit shall be provided with a factory assembled MERV 8 & 13 -filter section containing washable synthetic tube air filters having extruded aluminum frame.

iii. Accessories

The following accessories shall be provided with each air handlers

a) Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushy foot mountings, springs or approved equal type.

vi) Fan Coil Units

i. Scope of Work

The specification for Fan Coil Units covers the design requirement, constructional feature, supply, installation, testing & commissioning.

ii. The horizontal Type of Fan Coil

The horizontal type of fan coil units shall be complete with centrifugal blowers of aluminum construction, 3 speed permanent split-capacitor type fan motor, cooling coil, sandwiched type insulated drain pan extended type to accommodate all the valves as required for chilled water pipe connection.

The interior chassis shall be constructed of 16 gauge cold rolled galvanized sheet steel and painted with approved shade of powder coating finish. All ceiling suspended vertical fan coil units shall be securely mounted from the building structure. All FCUs shall be internally lined with 25 mm thick insulation (minimum 48 kg/m³ density and finished with 0.5 mm thick perforated aluminium sheet.)

Drain pan shall be fabricated from 18 gauge cold rolled stainless steel with all corners welded, and an additional inner bottom panel of 18 gauge stainless steel shall be provided to prevent damage to, and floatation of the bottom panel insulation. The pan shall be insulated with not less than 15 mm thick expanded polystyrene or 8 mm thick expanded polyethylene insulation sandwiched between top and bottom panels to effectively 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, bends control valves, strainers and entire copper piping.
The cooling coil shall be 3/4 row deep having minimum 4.7 fins / cm. The fins configuration of Sigma flow or plain fin shall be acceptable. The OD of copper tube shall be 9.5 mm minimum & wall thickness of 0.5 mm.

The fan shall be centrifugal, forward curved driven by 3 speed permanent split capacitor type fan motor. The Fan Coil Units shall be provided with the following accessories given below.

a) Double fire retardant Canvass Connection.
b) 12 mm thick cleanable aluminium filters with aluminium frame.
c) Strainer with ball valve at inlet & ball valve at outlet.
d) Copper connections between chilled water lines, controls etc.
e) Electrical wiring between motors & speed regulator.

It may be noted that all accessories specified above shall be provided along with the Fan Coil Unit and shall be included in the price of Fan Coil Unit.

Each Fan Coil Unit shall be tested at factory & complete in all respects. The sound level of the unit should not exceed 40 dB. The test certificate shall be furnished with each Coil Unit. It is necessary to design the fan coil unit in a way to have silent operation.

The Fan Coil Unit shall be powder coated both internally & externally.

iii. Technical Requirements of Fan Coil Units

The Parameters of Fan Coil Units are given below:

**FAN COIL UNIT-CEILING SUSPENDED**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>1.5TR</th>
<th>2.0TR</th>
<th>2.5TR</th>
<th>3.0TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Air quantity CMH</td>
<td>1020</td>
<td>1360</td>
<td>1700</td>
<td>2040</td>
</tr>
<tr>
<td>b) Fan Static pressure</td>
<td>6 - 8 MM External</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Face area of cooling Coil</td>
<td>500 FPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Minimum no. of fins / cm</td>
<td>4.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) No. of rows deep</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>f) Motor HP</td>
<td>(Fractional HP, Single phase)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Sandwiched tray</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Type of painting</td>
<td>Powder coated finish only</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

vii) Hot Water Generator

i. Scope of Work

This specification covers the design requirement, materials, constructional feature, manufacture & supply, installation, testing, commissioning of Electric Fired Hot Water Generator & Humidifier.
ii. **Codes & Standards**

The design, materials, manufacture, testing & performance of Hot Water Generator & Humidifier shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed. The Hot Water Generator shall also conform to the latest application of Indian Standards & Shall meet ASHRAE 90.1-2004 performance standards.

iii. **Constructional Feature of Hot Water Generator**

The hot water generator shall be Vertical / horizontal shell type. The shell shall be constructed out of 8mm thick Ms sheet and dishend shall be 10mm thick MS sheet with electric fusion welded seams & in accordance with ASME Boiler & Pressure Vessel Code, Section IV.

The shell shall be duly insulated & shall be mounted in a cabinet of suitable angle iron frame from 16 SWG mild steel sheet steel covers complete with hinges, locks etc. to make a sturdy compact assembly. The cabinet shall be provided with sufficient ventilation of heaters terminals of the boiler. The angle iron frames shall be provided with lifting lugs & pedestals.

The heaters shall be provided in such a way as to provide balanced distribution of the load. The electrical heater which shall be mounted within seamless copper sheathed electrically resistant U-Tubes, flange mounted with stainless steel studs. The heaters will be easily removable without opening of terminal plates. The heaters shall be suitable for 240±10%, 50±5% Hz, Single Phase AC supply and will be in direct contact with water contained in the shell.

Microprocessor based step controller with thermister sensor to control the HWG in stages. Features of this control should include dip switch programming, status LED's. Step controller shall have builtin test mode to verify Load wiring, contactors and stage operations with 1 Sec time delay. A separate power controller shall be provided for proportional control (0-100% load), in between the switching on and off of step control stages for precise temp. control up to 250KW and above 250KW a microprocessor based step controller with thermister sensor to control the HWG in stages.

The HWG shall be BMS compatible and RS-485 Communication port shall be provided for remote programming and control.

iv. **Controls & Accessories**

The hot water generator will be provided and not limited to following controls & accessories.

a) 100 mm dia dial type thermometer mercury in bulb at inlet & outlet (Range 0 -100 °C)

b) 100 mm dia pressure gauge with ball valve at inlet & outlet (Range 0 to 20 Kg/cm².)

c) Flow switch, float switch, automatic alarm for low water level and high temperature with independent indication lights.

d) Pressure relief valves.

e) Inlet & outlet pipes with flanges.

f) Drain points with valves.

g) Descaling valves.

h) Automatic airvent.

i) Thermostat for individual heater banks or step controller.

j) Safety thermostat.
v. **Pressure Testing**

The hot water generator shall be tested in the factory at 250 PSI

vi. **Insulation**

The hot water generator shall be insulated with 50mm thick fibre glass of density 32 Kg / m³ & cladded with 0.63 mm aluminum sheet on ms frame welded on generator body.

vii. **Electrical Control Panel**

The electrical control panel shall be mounted directly on the main frame conforming to standard specification of Indian Electrically rules. All controls shall be factory wired & tested.

a) Incoming MCCB with Copper busbar.
b) On-off Toggle switch for operating individual banks.
c) Contactor for individual banks with HRC fuses.
d) Indicating on/off lights status for individual banks.
e) Fault indicating lights.
f) Alarm with manual reset.
g) Copper connections with cable & control cabling.
h) Three phase ammeters & voltmeter with selector switch.
i) Microprocessor based step controller

j) Hot Water Generators shall be completely BMS compatible having Potential free Dry contacts for:
   a. System On/Off status indication
   b. Low Water Level Trip
   c. Hi. Temp. Trip
   d. Auto/Manual Selector Mode
   e. Start/Stop Command
   f. RS-485 Communication port for remote programming and control

The electrical panel doors should be openable only after total incoming power supply is cut off.

viii. **Painting**

The external surface of the shell shall be de-rusted, cleaned & applied with three coats of primer & finally have powder coating of approved shade.

ix. **Technical Requirements of Hot Water Generator**

a) Capacity As Per BOQ Given In The Tender

b) No. of HWG As Per BOQ Given In The Tender

c) No. of Banks

UP TO 75KW 3 Banks
x. **Humidification Arrangement**

The humidification arrangement shall be provided by AC contractors (wherever specified in the Bill of quantities. This shall consist of the following arrangement.

**Pan Type Humidifier**

A pan type humidifier of required capacity as specified in bill of quantities shall be provided. The pan type humified shall be constructed from 1 mm thick stainless sheet SS-304 with top cover openable for maintenance. The humidifier shall be complete with quick fill, make up overflow & drain connections. The humidifier shall be insulated with fibre glass of density 32 kg/cm² & shall be cladded with 22G thick aluminium sheet. The humidifier is divided in two chambers from inside, one bank of heater is always kept on to maintain water temperature between 60 to 70 °C with thermostat. All controls such as low level cut out, thermostat, float valve shall be provided. It shall be factory wired & tested. The humidifier shall have its own powder coated electrical panel made of 16 G CRCA sheet complete with contactors, MCB Low level cutout, Heating thermostat, fault indicating lamp, high temperature cutout etc. & internally wired.

[viii) Air-washer]

i. **Scope of Work**

The specification for package type double skin air-washer for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

ii. **Type**

The Air-washer system shall be Draw through type having 90% saturation efficiency with imported cellulose paper pads. The air washer shall be designed for maintaining inside temperature 5 - 7 °C higher than the outside wet bulb temperature.

iii. **Housing**

Double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 Kg / m³) shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticized sheet of 24 gauge thick and inner sheet of 24 gauge plain GI sheet. The entire framework shall be mounted on an aluminium 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 “O” rings gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium 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 double skin type. Recirculation tank shall be fabricated from 18-gauge stainless steel sheet duly reinforced with all corners welded. The tank shall be complete with double brass strainers, make-up connection with float, drain and overflow connections.
iv. **Fan**

The blower shall be Centrifugal Forward / Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Air-washer system shall comprise of one / two no. fans to handle air quantities as stipulated in BOQ. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of “V” Groove drives as per the recommendation of the drive supplier.

v. **Motor**

The TEFC motor shall be suitable for 415 ± 10% volts, 3 phase, 50 Hz ± 5%, A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

vi. **Pre Filter Section**

The filter section shall incorporate cleanable aluminum filters of size 610 x 610 x 50 mm thick made out of 18 G with aluminum fill only. The velocity across the filters should be limited to 152 MPM. The filter bank should be mounted in 16 G aluminum frame with provisions of removal of filter for cleaning. The filtration capacity of the filter shall be down to 10 micron particle size with the minimum efficiency of 90%.

vii. **Air Washer Section**

The air-washer section shall consist of imported cellulose paper pads of intersecting angle of 45/15 OR 60/30 Deg. The fill shall be cross fluted configuration assembled in self supporting pads in light weight construction. The pads shall be able to redistribute the water & shall be impregnated with insoluble antiriot salts rigidifying saturates & wetting agents with built in eliminators.

The velocity across the fill shall not exceed 152 MPM & shall not allow carryover water. A FRP distributor should evenly distribute water on the fill. Eliminator plates shall be four bend made from 24 gauge galvanized sheet steel or PVC.

The efficiency of fill should be able to perform with an efficiency of 90% minimum & thickness of fill should be 200 mm minimum.

viii. **Tank & Wet Section**

The tank & wet section shall be made out of 18G stainless steel only.

ix. **Pump, Piping & Valves**

The air-washer shall be provided with monoblock pump set as specified in Bill of Quantities. It will be complete with inter connecting GI medium class piping, GM gate valves, check valves, Y-Strainers, suction screen etc. The accessories shall include make up, drain, over flow, quick fill & brass float valve, canvass connections at each blower outlet.

x. **Efficiency**

The overall efficiency of air washer system shall be at least 90% and factory test certificate shall be submitted along with the equipment.

xi. **Installation**

The fans, pumps, air-washer / scrubber etc. shall be provided with necessary vibration isolation cushy foot mounts. The contractor shall arrange all necessary accessories such as nut bolts etc.. The contractor shall arrange his own labour with material for completion of assembly.
The contractor, if specifically specified in bill of quantities, shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

xii. **Transit Damage**

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

xiii. **Testing**

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished with the bid by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

H.15 It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the owner from all liabilities arising out of any objections raised by the local authorities in this regard.
ix) Scrubber

i. Scope of Work

The specification for package type double skin scrubber for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

ii. Type

The scrubber shall be double skin spray type system & shall be draw through type as specified in the BOQ.

iii. Housing

Double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 Kg / m3) shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticized sheet of 24 gauge thick and inner sheet of 22 gauge plain GI sheet. The entire framework shall be mounted on an aluminium 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 ‘O’ rings gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium 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 double skin type. Recirculation tank shall be fabricated from 18 gauge stainless steel sheet duly reinforced with all corners welded. The tank shall be complete with double brass strainers, make-up connection with float, drain and overflow connections.

iv. Fan

The blower shall be Centrifugal Forward / Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Scrubber shall comprise of one / two no. fans to handle air quantities as stipulated in BOQ. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of “V” Groove drives as per the recommendation of the drive supplier.

v. Motor

The TEFC motor shall be suitable for 415 ± 10% volts, 3 phase, 50 Hz ± 5%, A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

vi. Pre Filter Section

Filters section shall incorporate metallic viscous filter (for removal of oil and grease) of thickness 50 mm in suitable aluminium frame. Velocity of air across the filters shall not exceed 2.5 m/s.

vii. Spray Arrangement

The wet section will have 18 G SS Tank and body with folded construction with the bolted openable sides also in 18 G GI sheet. Spray arrangement shall be 2 bank air washer with 1/8” (3 mm) bore bronze nozzles with brass plug complete with GI pipes and spray headers. Minimum number of nozzles
shall be 1 / sqft of face area. Face velocity not to exceed 500 FPM (2.5 m/s). PVC drain/overflow and bleed off outlet are to be provided on all wet sections.

viii. **Pump**

The unit will have a single phase 220 volts + 10% 50 c/s power supply monoblock self priming pump assembly to provide recirculated tank water and a pressurized flow via a piping system for proper water distribution. The pump capacity will be such that it can take care of the bank of Nozzles provided and the rigid media.

ix. **Installation**

The fans, pumps, scrubber etc. shall be provided with necessary vibration isolation cusky foot mounts. All necessary accessories such as nut bolts etc. shall be arranged by the contractor. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in bill of quantities, shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

x. **Transit Damage**

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

xi. **Testing**

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished with the bid by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

I.12 It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the Department from all liabilities arising out of any objections raised by the local authorities in this regard.

x) **Ventilation Fans**

i. **Scope of Work**

The specification for supplies & exhaust air blowers for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

ii. **Type**

The blower shall be of Tube Axial Flow fans / Centrifugal Fans / Inline fans / Propeller Fans / Jet Fans with or without ducting system & shall be of floor mounted / ceiling hung type.

iii. **Capacity**

The capacity of Tube Axial Flow fans / Centrifugal Fans / Inline fans / Propeller Fans Jet Fans, diameter, maximum motor H.P & static pressure etc. shall be according to schedule of quantities.
iv. **Axial Flow Fans**

The exhaust air blower shall be Tube Axial Flow fans connected to the duct & shall be of floor / ceiling / wall mounted type as specified in the Bill of Quantities / GFC Drawings / Shop Drawings. The capacity of tube axial flow fans, diameter, maximum motor H.P & static pressure etc. shall be according to schedule of equipment & Bill of Quantities. The noise level of axial fan shall be less than 80 dBA at a distance of 3.0 mt from the fan.

Axial Flow Fan shall be **AMCA certified** for Air and Sound performance in accordance to **AMCA 210 and AMCA 300**.

The cylindrical casing shall be made from MS / GI welded carbon steel sheet. The length of casing shall be long to accommodate motor within the casing. Casing thickness shall be minimum 2mm up to 800 mm dia fan, 3 mm thick from 900 to 1250 mm dia & 4 mm thick above 1300 mm dia. The inlet & outlet of the casing shall be fitted with flanges for ductwork connection & other accessories as required. The casing shall be coated with minimum 2 coats of rust proof primer and enamel paint thereafter or to be Powder Coated after phosphating process. The blade of axial flow fan shall be made of die cast aluminium alloy. The blade angle shall be set at manufacturing place & shall be adjustable at site. The hub shall consist of two half-hubs pressed in carbon steel & the centre boss shall be made of die-cast aluminium alloy. The blade feet shall be locked in two half - hubs. The design shall facilitate the alteration of blade angle without disconnecting the hub from the motor shaft. The fan shall be directly driven by TEFC sq. cage induction motor. The fan motors shall be 415±10% volts 50HZ ± 5%, 3 phase TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor RPM shall be as given in Bill of Quantities.

Complete fan with motor shall withstand 250 °C temperature for 2 hours & shall work satisfactorily at this temperature.

Complete Fan assembly for smoke extraction application (Fan Impeller, Fan Casing, Motor base frame along with Motor) shall be tested and approved by UL in accordance with "Power Ventilators for Smoke Control Systems" for (300 degree C) temperature for a 2 hours of operation.

v. **Centrifugal Fans**

The Centrifugal blowers shall be double / single inlet, double / single width, forward / backward curved as given in the BOQ & of non-overloading type of suitable construction. The blower performance must be rated in accordance with approved test codes and procedures. The centrifugal fans should confirm to IS – 4894 – 1987 (Revised as on date) The blower housing comprising of scroll & side plates shall be accurately cut of heavy gauge construction and reinforced with angle bracings. Outlets shall be flanged to assure proper duct connection. Inlet cones shall be spun venturi type, to ensure smooth air entry. The base frame shall be GI / MS channel in bolted / welded construction. Impeller shall be fabricated from sheet steel with backward / forward curved, properly designed blades, with heavy C.I. Hub and shall be both dynamically and statically balanced, to a close tolerance for quiet and vibration free performance. Shaft shall be EN-8, more than 40 mm diameter and shall be accurately ground and polished to a close tolerance. Bearings shall be self aligned, heavy duty ball or tapered roller type with integral dust and grease seals. Fan having wheel diameter of 1220 mm or more, shall be supplied with split, bolted housing for convenience of handling and installation.

Drive assembly for each blower shall consist of blower pulley, motor pulley, and a set of ‘V’ belts, belt guards, and belt tension adjusting devices. Pulleys shall be selected to provide the required speed. They shall be multi-groove type, with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced. The belt guards shall be of M.S. sheet with angle iron reinforcements and expanded metal screen. The fan motors shall be 415±10% volts 50HZ ± 5%, 3 phase TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor RPM shall be as given in Bill of Quantities.
vi. **Propeller Fans**

The Propeller Fan blades shall be pressed steel of aerofoil design for high fan efficiency and static pressure. The blades shall be riveted to a central steel hub. The motor and blades assembly shall be mounted in a cast iron / sheet steel frame with steel brackets. Rubber mounts shall be provided between the mounting frames and brackets. The fan motor shall be totally enclosed type.

vii. **In-Line Fans**

Inline fans shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly. Housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal parts shall be either spot-welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing. Fan wheel shall be forward curved type, statically and dynamically balanced. The fan shall be provided with ball bearings can be used in any mounting position at maximum indicated temperature.

viii. **Jet Vent Fan**

The fans shall be die-cast aluminium alloy impeller shall be high temperature applications 300 Deg C for 2 hours operation. Fan shall be balanced dynamically and statically. The Casing of Fans shall be made of hot dipped Galvanized steel / powder coated with flanges at both ends. The Motor shall be run on the electrical power suitable for 50Hz. The certification of fans should be in accordance with EN 12101-3 or shall be UL. Fan shall be either EN / UL listed & Stamped for electrical components. The fans shall be protection guards at inlet & outlet side. The Fans shall be silencers manufactured from Galvanized steel length minimum 900 mm to achieve specified noise levels. Fans shall have Inlet cone & out cone made of Galvanized steel. The pre-wired Terminal box is mounted at the outer fan Casing. The unit shall be with mounting brackets for ceiling suspension. Final locations of the jet fans shall be based on the CFD simulation to be submitted by contractor before manufacturing. The Jet Fan Supplier shall include the cost of CFD Analysis & shall select the size and positioning of the fans, giving velocity vectors, static pressure contours, simulations of smoke spreading and other information required for the project.

ix. **Accessories**

All necessary accessories shall be provided for proper operation and shall also include as part of Unit Price.

- Dunlop cushy foot vibration isolators for the blowers
- Double canvas connections at the outlets of each fan
- Nuts, Bolts, Shims etc. as required for the grouting of the equipment
- Slide rails for mounting the motor and belt adjustments
- Bird Screens in the Inlet
- Detachable and washable fresh air filters at the inlets

x. **Performance Data**

All fans shall be selected for the lower operating noise level. Capacity ratings, power consumption, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. All the fans should be AMCA certified for sound and performance. Complete certified model appearing on AMCA web site shall be accepted.
xi. 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 input current. Contractor has to carry out the field balancing, if required.

xi) Automatic Control & Instruments

i. Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of automatic controls and instruments conforming to these specifications and in accordance with Bill of Quantities.

ii. Type

All automatic controls shall be electrical / electronic controls as described in the tender specification.

Automatic controls required for various types of machines have been described in the various sections of these specifications. The manufacturers before shipment may install the individual safety controls and selected automatic controls within the machines. However, the AC Contractor, if not already installed on the machines, may install the following automatic controls, at site.

iii. Controls for Air-handler & FCU

The Valve should be self-balancing dynamic flow control valves that are pressure independent, two-way, Modulating to accept digital or analog input signals and provide flow feedback signal to the control system.

Two way modulating valve complete with pressure independent dynamic balancing capability for each air handling units shall be provided in chilled water line at each air handling unit. A space temperature sensor shall actuate each valve. 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 close position (two way valve) when fan is shut off. Motor shall be proportional modulating motor. Motor shall be suitable for 24 volts supply and shall have an integrated mounted 220/24 volts transformer factory-installed.

Controls shall be capable of providing a temperature dead band of 3 deg C within which the supply of heating and cooling energy to the zone is shut off or reduced to minimum.

Thermostats shall be interlocked to prevent simultaneous heating and cooling.

iv. Flow Switch

Flow Switch shall be provided in condensing water outlet and chilled water outlet at each water-chilling machine. Flow switch shall prevent the compressor from starting unless the water flow is established in condensing & chilled water lines. Time delay shall be incorporated for flow switch to avoid false alarms.

v. Thermostat

The thermostat shall be electric, fixed differential cooling / heating type as specified with sensing element located in return air stream. All thermostats shall be supplied with the standard mounting boxes as recommended by the manufacturer.
If the BOQ asked for digital thermostat then it has to be installed which will have provision of setting of room temperature, setting of fan speed (High, Medium, Low) & for Humidistat, it shall be also of digital display type, which shall have provision of setting the RH and display space RH also.

Thermostats shall be interlocked to prevent simultaneous heating and cooling.

vi. **Instruments**

a) Thermometer: The alcohol filled V-form thermometer shall have range of 50 °C. for air-conditioning application. These shall be provided at inlet / outlet of chillers & air-handlers.

b) Pressure gauges: The pressure gauges shall be dial type of 150 mm dia to be installed at inlet / outlet of chillers, condensers, suction and discharge ends of pump-sets. The air-handlers shall have common pressure gauge for inlet & outlet. The pressure gauges shall be connected to the pipes by common dia copper pipe with shut off cocks required for gauges protection during testing.

vii. **Calibration & Testing**

All automatic controls & instruments shall be factory calibrated & provided with necessary instructions for site calibration & testing. Various items of the same type shall be completely interchangeable and the manufacturer shall guarantee their accuracy. All automatic controls & instruments shall be tested at site for accuracy & reliability before commissioning the installation.
xii) Variable Frequency Drives

i. Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of variable frequency drives conforming to these specifications and in accordance with Bill of Quantities. The VFD should be specially designed & applicable for HVAC field & general-purpose product shall not be acceptable. AHU VFD shall be with IP-55 enclosure, mains disconnect & 4 PID controllers.

ii. Certification UL, CE

iii. VFD Design Requirements

1. Voltage Variations 380-480V
2. Nominal supply frequency 50 Hz ± 5%
3. True Power Factor (λ) > 0.9 at nominal rated load
4. Displacement P.F. (cos φ) > 0.98
5. Short circuit current rating 100 kA RMS
6. Harmonic current control 5% non-saturating dual reactors on both rails of DC bus. Swinging chokes which do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non linear) DC reactors to provide additional 3% AC chokes.
7. EMC Compliance (for emission and immunity)
   a) For powers ≤90 kW : Shall comply with requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable.
   b) For powers >90 kW : Shall comply with requirements of IEC 61800-3 :2004, Category C2 with 50m motor cable.
8. VFD rated continuous output current Meet or exceed the normal rated currents of standard IEC induction motors
9. Torque mode Variable torque. Not programmable in constant torque mode for variable torque fan and pump applications
10. Torque ratings
    a) Starting torque : 135% for 0.5 seconds
    b) Overload torque : 110% for 1 minute
11. Cable lengths
    a) Upto 150 m for screened / armoured cable
    b) Upto 300 m for unscreened / armoured cable
12. Cable type To allow for SWA (Single Wire Armour) cable & MICS (Mineral Insulated Copper Sheath) cable in the motor circuit.
13. V/f ratio Dynamically varying; fixed V/f curves not acceptable
14. Energy optimization function Automatic energy optimization algorithm, which continuously adjusts the applied voltage based on load and speed.
15. Output power switching Without any interlocks and damage to VFD
16. Motor tuning function Automatic, without having to decouple the load and motor.
17. Signal Isolation Galvanic Isolation between power and control circuitry
18. System response time < 2 ms
19. Motor noise reduction Adjustable carrier frequency modulation. VFDs with fixed switching frequency not acceptable
20. Ramp time Programmable from 1 to 3,600 seconds

iv. VFD Service Conditions
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

1. Ambient Temperature with full VFD rated output current:
   a) For powers ≤90 kW: 45°C without derating
   b) For powers >90 kW: 40°C without derating

2. Relative Humidity: 0 to 95%, non-condensing

3. Max. altitude above sea level: Upto 1000m without derating

4. AC line voltage variation: U±U 10% of nominal with full output

5. VFD enclosure protection: IP20/IP21/IP55 integral with no additional cabinets

6. Aggressive environment: Class 3C2

7. Vibration: 1.0 g

v. VFD Protective Features


2. Protective functions:
   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.

3. Function at input phase loss: Auto derate and warning. Should cause no damage to VFD

4. Function at over temperature: Automatically reduce carrier frequency or auto derate.

5. Function at over load: Automatically reduce output current to a pre-programmed value

6. Alarm log: Record last 10 alarms with description of alarm, date & time.

7. Dry pump detection: Automatically detect and trip during a dry running situation or no flow condition, when used in pumping application

8. End of curve protection: Detect and display a warning or trip when encountering an end of curve situation, when used in pumping application

vi. VFD Interface Features

1. Customer interface: Identical interface for full range of VFDs in a project

2. Display type: Graphical, alphanumeric, 6 line, back lit

3. Auto – Manual operation: Control panel to have inbuilt Hand – Off – Auto Keys

4. Programming assistance key: Key for displaying on-line context sensitive assistance for programming and troubleshooting.

5. Protection against unauthorized access: 2 level password protection for read & write to prevent unauthorized access.

6. Parameter up load / down load: Control panel with program up load / down load function and also size / rating independent parameters.

9. Languages: English

10. Indicating lamps: Red FAULT light, yellow WARNING light and a green POWER-ON light.

vii. VFD HVAC Features

1. Quick set up menu: Menu with factory preset typical HVAC parameters

2. HVAC application menus: Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

3. Speed control using 3 feedback signals: A three-feedback PID controller to control the speed of the VFD

4. 3 – zone control: Sum, difference, average, compare to common set point or compare to individual set point and select min. or max. deviating signal

5. Square root function of feedback: Calculate the square root of any / all individual feedback
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal</td>
<td>signals so that a pressure sensor can be used to measure airflow</td>
</tr>
<tr>
<td>PI Programming</td>
<td>Auto tuning PI controller to facilitate faster commissioning</td>
</tr>
<tr>
<td>Installation of pressure sensor near to output of pump.</td>
<td>Actively adjust its set point based on flow, to facilitate such installation</td>
</tr>
<tr>
<td>Independent PID controllers</td>
<td>Three Nos., additional PID controllers to control damper and valve positioners in the system and to provide set point reset</td>
</tr>
<tr>
<td>Floating point control interface</td>
<td>To increase/decrease speed in response to contact closures.</td>
</tr>
<tr>
<td>Meter displays</td>
<td>5 simultaneous meter displays on LCP</td>
</tr>
<tr>
<td>Display of feedback signals and set points</td>
<td>Display all connected feedback signals and its set points, in their own engg. units (e.g. : bar / °C etc.)</td>
</tr>
<tr>
<td>Sleep mode</td>
<td>Programmable and be able to stop the VFD in the following situations: a) Output frequency drops below set “sleep” level for a specified time, b) External contact commands that the VFD go into Sleep Mode, or c) Detects a no-flow situation.</td>
</tr>
<tr>
<td>Run permissive circuit</td>
<td>Receive a “system ready” signal before starting and also be capable of initiating an output “run request” signal to the external equipment.</td>
</tr>
<tr>
<td>Loss of load detection</td>
<td>Monitor a broken belt / loose coupling and indicate via keypad warning, relay output or serial communication. This function shall be based on torque and shall have a proof timer.</td>
</tr>
<tr>
<td>Real time clock</td>
<td>Integral feature and shall be capable of: a) Display current date &amp; time on control panel b) Start / stop, change speed depending on time c) Time stamp all faults d) Program maintenance reminders based on time</td>
</tr>
<tr>
<td>Energy log</td>
<td>Function to monitor energy consumption pattern over programmable hours, days &amp; weeks</td>
</tr>
<tr>
<td>Load profile</td>
<td>Store a load profile to assist in analyzing system demand and energy consumption</td>
</tr>
<tr>
<td>Sequential logic controller</td>
<td>To perform logic functions which has logic operators, comparators and timer functions.</td>
</tr>
<tr>
<td>Cascade controller for multiple motors</td>
<td>To control one variable speed motor and 2 fixed speed motors. Software to have full functionality and not just on / off</td>
</tr>
<tr>
<td>Automatic restart</td>
<td>To automatically restart on receiving power after a power failure</td>
</tr>
<tr>
<td>Adjustable ramp time</td>
<td>To avoid nuisance tripping, automatically adjust the ramp times.</td>
</tr>
<tr>
<td>Catching a spinning fan</td>
<td>To have a flying start function to effectively control an already spinning fan – in both forward and reverse direction</td>
</tr>
<tr>
<td>Programmable current limit</td>
<td>Programmable for site / application requirement. Shall be able to program for trip after an adjustable time</td>
</tr>
<tr>
<td>Start Delay</td>
<td>A programmable start delay shall be provided.</td>
</tr>
<tr>
<td>Critical frequency lock out</td>
<td>a) Semi automatic setting of lock out range. b) 4 such lock out ranges to be provided</td>
</tr>
</tbody>
</table>

viii. **VFD Input & Output**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital inputs</td>
<td>At least 4 programmable digital inputs</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>2</td>
<td>Digital outputs</td>
</tr>
<tr>
<td>3</td>
<td>Relay outputs</td>
</tr>
<tr>
<td>4</td>
<td>Analog inputs</td>
</tr>
<tr>
<td>5</td>
<td>Display of analog signal</td>
</tr>
<tr>
<td>7</td>
<td>Optional I/O modules</td>
</tr>
<tr>
<td>8</td>
<td>Serial com interface for AI/DI</td>
</tr>
<tr>
<td>9</td>
<td>Serial com interface for AO/DO</td>
</tr>
<tr>
<td>10</td>
<td>Fire over ride mode</td>
</tr>
</tbody>
</table>

ix. **VFD Serial Communications**

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:
   a) Metasys N2
   b) Modbus RTU

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.

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.
xiii) Specification of BMS for MEP Work

i. General

The Building Automation System (BACS) supplier shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, suitable for the building usage. The control strategies shall be developed to ensure that the specified environmental conditions are maintained, whilst giving due regard to minimising of energy consumption.

The system design shall utilise the latest technology in “open” network architecture, distributive intelligence and processing, and direct digital control. The BACS system offered should be from the latest offerings and should be of freely programmable management and automation stations for the full spectrum of today’s building application services.

All peripheral equipment e.g. sensors, pressure switches, control valves and actuators, shall be of the same manufacture as the direct digital control modules and outstations.

The system offered shall be completely modular in structure and freely expandable at any stage from the smallest system through to large distributed systems. Each level of the system shall operate independently of the next level up.

The system shall fully be consistent with the latest industry standards, operating on Windows 2000, Windows XP or later, allowing the user to make full use of the features provided with these operating systems.

To provide maximum flexibility and to respond to changes in the building use, the system offered shall support the use of BACnet, LON, Profibus and Ethernet TCP/IP communication technologies.

The contractor shall establish the number of equipment to be controlled / monitored by the BMS from the drawing/ schedule/ specifications. This information shall be furnished to the BMS supplier. All plant and equipment requiring control and / or monitoring functions shall be fitted with all necessary interfacing equipment readable by the BMS network. The contractors shall co-ordinate and ensure that this equipment shall provide the required signals to the BMS.

ii. Essential functions of system

The system comprises the supply, engineering, testing and commissioning of an integrated building management system by a specialist manufacturer.

The essential functions of the system are as follows:

- Centralised operation of the plant (remote control)
- Dynamic and Animated Graphic details of Plant and building
- Tenant Billing for BTU Consumption
- Early recognition of faults
- Faults statistics for identification
- Trend register to identify discrepancies, energy consumption, etc.
- Preventive maintenance and plant servicing
- Optimum support of personnel
- Control optimisation of all connected electrical and mechanical plant
- Prevention of unauthorised or unwanted access
- Own error diagNos.,is integrated system
- AutoCAD integration

iii. General System Architecture

The system shall be logically structured into three distinctive levels, which are Management Level, Automation Level, and Field Level. Each level shall be autonomous from the other. Peer to peer
communication shall be possible on all system levels and the system design shall be modular in structure to allow straightforward extensions.

iv. Use of communication standards

Only the following standards are appropriate to be used at the three levels.

- Management level - BACnet, Ethernet TCP/IP
- Automation level - BACnet on LonTalk
- Field level - LonTalk with LonMark profiles

v. Management Level

The head-end management and operation of the plant shall include process visualization, data analysis, and exchange of data with 3rd parties. At the management level, it shall be possible for communication to flow in all directions, across networks and via direct connections.

Personal computer based operator management stations shall be provided for plant supervision and operation, alarm management, information and database management function. All real-time control functions shall be resident in the DDC controllers to facilitate greater fault tolerance and reliability.

The operator management station should be capable of multi-tasking 32-bit programs by utilizing a Microsoft Windows 2000 or XP operating system.

The management level of the system shall consist of one, and shall be capable of handling more management station PCs and the associated software modules. The number of total number of management station PCs shall be as described elsewhere in the specifications.

The management station shall be capable of the following:

- Display of graphical representations of the plant overlaid with live data
- High quality dynamic graphics with true multitasking of all active pages
- Monitor and operate / influence process devices
- Receiving of alarm messages from the process level and directing them to the appropriate reporting device e.g. printer, pager, fax, e-mail
- Monitor process devices for communication problems and other device faults.
- Alarm handling – all the alarms shall be displayed in a graphical tree structure in order located alarms quick and easily.
- Adjusting time strategies in the process level.
- Long term storage of logged data from the process devices
Multi level user access control for individual access to sites, applications, functions and objects

Display graphically the logged data

Custom application programming

Use of graphical genies to allow manipulation of data.

The user interface shall be based on a basic taskbar, which is always visible.

History logging for alarms, user actions, system events and messages

Alarm handling – all the alarms shall be displayed in a graphical tree structure in order located alarms quick and easily.

Simultaneous connection of at least of 4 sites via serial connections / 50 sites via LAN/WAN connections for a comprehensive overview on geographically distributed projects

For maximum fault tolerance, the management stations connect to the process level via point-to-point communications. This shall be via RS232, Ethernet/TCP/IP LAN / WAN or via AutoDial links.

vi. **Automation Level**

General Purpose controllers shall be used for monitoring / controlling equipment which have to perform based on a customized logic, such as AHUs, Chillers, Chilled water pumps, Cool towers, Lifts, signals from Fire Alarm panels, generators, transformers etc.,

At the heart of the DDC system shall be the Microprocessor based modules, which can be individually programmed according to the functional requirements.

The automation level DDC controllers shall monitor and control the main plant in the building. The DDC controller outstations shall be freely programmable and have the ability to perform all the following routines

- Process control & interlock functions.
- Generate alarms/events based on comparing measured values against know parameters.
- Time control strategies
- Runtime totalisation
- Trend logging of specific data-points with transmission of the logged values to the management level
- Energy calculations
- Backup of the data/program

The DDC controllers shall be selected from either a modular or compact type of unit to suit the most economic inclusion of all the data points specified. Each control module shall be capable of operating on a stand-alone basis without control from a central computer.

The input/output connection to Modular controllers shall be via individual plug-in modules suitable for the particular peripheral device. The digital modules shall have visual indication of the status of the input/output. Digital input modules shall be capable of accepting control voltages up to 230vac and will have integral status indication.

It shall be possible to integrate both types of control module onto the same BACnet communication network. Each controller performance shall be to 0.5% control accuracy with sample rates of less than one second.

Main plant DDC controllers shall be 16 / 32 bit freely programmable. Controllers meant for VAV controls cannot be used as DDC controllers.

All DDCs must be UL approved, must have an in-built real time clock and be suitable for PID control.

The products used in constructing the BMS management and automation levels shall conform to BACnet protocol on a LONtalk data communications network, for building automation and control networks. All product types shall have attained a BACnet Testing Laboratories (BTL) listing and display BTL logo.
Room units shall utilize a two-wire communication link at each controller for the acquisition of room temperature and local set point. These will also provide an integral temperature/set point digital display.

The system shall have the facility for a Web server to be added to allow full operation of all automation station control modules connected to the LonTalk BACnet network via a standard thin client/web browser. Functions to include:

- Display of graphical representations of the plant overlaid with live data
- Data point display and operation of all measured values, set points, plant states, operating states and parameters
- Alarm monitoring with acknowledgement and visual and audible alarm indication.
- Alarm and event history
- Alarm transmission via SMS and e-mail
- Operation of all time schedules, exception calendar and heating curves.
- Reading of trend data with facility to export data to Microsoft Excel.
- Multi user level access protection
- Ethernet or Modem connection

**DDC Control Module Specification**

The DDC controllers shall be selected from either a modular or compact type of unit to suit the most economic inclusion of all the data points specified. The DDC controllers being used should confirm to the following specifications as a minimum:

- Based on ANSI/ASHRAE standard 135-2001 (BACnet), ENV13321-1
- Operation standalone or as part of LonTalk (clause 11) system network TP/FT-10, 78kBits with Built in BACnet/Lontalk interface
- Optional connection to operator terminal, management station and via Web browser with Web server device.
- Freely Programmable
- Flash ROM, real time processing and multi tasking
- 32 bit dual processor system, 1.5 MB program memory
- Supply voltage AC 24V +/-20% 50/60 Hz
- Event driven data transmission
- Automatic mains recovery
- PPS2 connection for up to five two wire QAX room units
- Digital output to be 250V 2A rated changeover contacts
- Historical data memory storage
- Software application stored in non volatile memory
- Battery back up

For the generation of the application programs, the following function elements are required as a minimum:

- Reset functions
- Set point jump
- Positioning time
- P-controller (reverse or direct acting)
- P1-controller (reverse or direct acting)
- PI-controller with I-deletion (reverse or direct acting)
- PID controller (reverse or direct acting)
- 2-point controller (reverse or direct acting)
- Proportional additional sequences (reverse or direct acting)
- Data transmitter (digital or analogue)
- Data converter (analogue-digital or digital-analogue)
• Ring Counter
• Timer (switch on or switch off)
• Logic operations:
  o logic "AND" (2,3 or 4)
  o logic "OR" (2,3 or 4)
  o logic "EXOR"
  o logic "NOT"
• Comparative operations:
  o Maximum values (2,3 or 4)
  o Minimum values (2,3 or 4)
  o Average values (2,3 or 4)
• Enthalpy calculation
• Optimiser
• Mean value calculation
• Hysteresis
• Output steps (digital or analogue)

Digital outputs shall be potential free outputs. Analog outputs shall be true analog outputs (0-10 V DC, 0-20 V DC, 0-20 ma & 4-20 ma)

Above blocks shall be resident in the DDC Controllers and independent of any high level interfaces/controllers.

Further, the DDC unit software must have the following additional functions:

Free selection of range and unit (dimension) of all signals (measured values, accumulated values, calculated values, etc.)

Free allocation of access protection in accordance with operating priorities

Free definition of manual override priorities (software) from operator terminal and/or management station.

**Each DDC Controller shall have a resident real time clock with a battery back up.**

All DDC controllers shall be housed in IP 54 enclosures with proper termination of peripheral devices at the terminal strip and not directly to the controller.

vii. **Field Level**

Individual terminal unit controllers for autonomous room – by – room comfort control, based on application specific logic written on the controllers. All the terminal unit controllers shall fulfil following general requirements:

• LONMARK communication
• AC230 V power supply
• Mountable with screws or DIN rail
• Optional terminal cover for local installation without cabinet
• Downloadable application software /adjustable parameter set, the type of use shall be defined by downloadable pre-tested application software.

Common functions like grouping, scheduling, etc., shall be realised within a master controller on automation level.

All terminal unit controllers supplied on the project shall have the facility for local set point adjustment via a room unit.
Application specific controllers shall be used for terminal devices such as Fan Coil Units and the like. These controllers shall be with LonMark compatible bus communication. Any failure problem in communication bus should not affect the working of the FCU controller. A dedicated stand alone controller shall be provided for each FCU. A common controller for FCUs serving different areas shall not be acceptable. These controllers shall be looped with a bus cable and connected to the BMS via an interface unit.

In general they shall comply with the following specifications

- For 2 or 4 pipe FCUs, with or without changeover
- PID control
- Downloadable application software
- LonMark compatible bus communication
- To be integrated to the management station software
- Control of AC 24 V PWM valve actuators, 3 point AC 24 V valve and damper actuators, or electric heating coils
- Volt-free relays for fan control
- Operating Voltage 230 V
- Internal fuse, thermal, automatic reset
- Connectable to 1 room unit via PPS2, 4 wire unscreened twisted pair @ 4.8 KBPS

The application specific controllers shall be capable of working in conjunction with the following type of room controllers. The specific type of room controller to be used in specific applications shall be selected from any one of the following types to meet the description written in the sequence of operation.

**TYPE 1**
- Integrated room temperature sensor

**TYPE 2**
- Integrated room temperature sensor
- Dial for temperature set point

**TYPE 3**
- Integrated room temperature sensor
- Dial for temperature set point
- Rocker switch for off/auto1 mode (single speed fan)

**TYPE 4**
- Integrated room temperature sensor
- Dial for temperature set point
- Rocker switch for off/auto1 mode and fan speeds (3 speed fan)

**TYPE 5**
- Integrated room temperature sensor
- Dial for temperature set point
- Rocker switch for off/auto1 mode and fan speeds (3 speed fan)
- LCD display of measured temperature

**TYPE 6**
- Integrated room temperature sensor
- Rocker switch for temperature set point (raise/lower)
- Rocker switch for off/auto1 mode and fan speeds
- LCD display of measured temperature
- Communication with controllers via Lon bus
- Exchangeable rocker switches for lighting and blinds
- Selection of downloadable software applications for the operation of lighting and blinds
• Operating mode ‘auto’ – comfort, ‘off’ – standby or economy

**FCUs FOR CORRIDOR/ LOBBY AREAS**

Each FCU control assembly shall consist of a dedicated controller mounted near the FCU and temperature sensor mounted in the return air path.

The FCU controller shall automatically change the FCU motor speed based on the temperature deviation. The FCU shall continue to operate at the low speed when the temperature conditions are achieved. It shall be possible to switch OFF the FCU motor either from the ON/OFF switches of the room unit or via BMS PC.

The temperature set point shall be selected through the set point provided on the controller fascia or via communication bus/ BMS PC. It shall also be possible via the communication bus to operate the controller in comfort mode (normal operation) stand-by mode (short break periods like lunch time etc.) and energy hold off mode (night mode or non-office hours) through time channel programming.

The FCU controller shall modulate the modulating valve to meet the desired temperature condition.

In case multiple FCUs are serving the same common area/ lobby a common controller can be used if suitable from the site conditions.

viii. **Networks & File Servers**

Wherever the building configuration supports in - built network cables, the system shall be able to accommodate several PCs hooked up at locations designated by the user at a later date. The management station software shall support the two leading network systems, Windows NT Advanced Server and NOVELL NetWare.

The management station(s) shall be set up on the network in two different ways, either operating independently or as client management stations in conjunction with an (optional) file server.

To facilitate central storage of data and programs, the file server is envisaged. Central management of user-specific information such as passwords and protected access to data and programs shall thus be made easily possible. The file server shall also support software updates and changes in the project data. The file server shall also support consistent central archiving of alarms, off-line trend data, log data, graphics, data backup etc.

ix. **Printing**

It shall be possible to connect printers either directly to the management station or to the file server.

x. **Remote Monitoring and Control (Optional)**

It shall be possible, with additional hardware if necessary, to interrogate the system remotely via the following possible methods:

• Telephone connection
• Building IT network
• Web browser technology with password access via IT networks accessing information stored on dedicated embedded web server device installed on automation controller network.
• Alarm reporting to mobile pagers/phones/e-mail etc
• Energy usage monitoring and control via Design Insight Building Management Systems.

xi. **BMS – Records**

**General**
The details of the building automatic system shall include all the manufacturers Technical Data Sheets and User Manuals. Control valve schedules shall be provided the flow rates; valve pressure drop and system design basis on which the particular valve type was selected.

**DDC Control System Software Strategies**

Controller strategies shall be provided, in both hard copy and on CD-ROM, for inclusion in the Operating & Maintenance Manuals.

Copies of all the preliminary strategies, in both hard copy and on CD-ROM, shall be supplied to the Engineer prior to commencement of control systems commissioning.

Copies of all the ‘As Installed’ strategies, in both hard copy and on CD-ROM, shall be supplied to the Engineer within three months of hand over of control systems.

**BMS Software and Licenses**

All License rights to the control systems manufacturers software packages shall be transferred to the client at the time of hand over. User Registration must be made on behalf of the client, direct to the control system manufacturer by the specialist System House Partner.

Copies of all of the control system manufacturers Monitoring or BMS software shall be provided on CD-ROM, or other mass storage device, together with copies of any graphics and databases that may be required to re-install the system after a fatal computer failure.

**Integration of secondary systems**

Integrations shall be carried out at the most appropriate level within a system, depending on the functions and interaction required. The following integrations must be possible.

- LonWorks
- LonMark
- BACNet /LonWorks
- BACNet/IP
- OPC
- Integration of standard proprietary buses: Modbus, M Bus, KNX.

As part of the requirements for an open system devices with a Native BACnet protocol shall be connected onto a common field bus backbone network directly without any Gateway/Protocol converter device. If interaction is required between different sub-systems, the integration shall be carried out at either the automation or field level. The integration must not occur at the management level. Link to a third party software package such as a Planned Preventive Maintenance package or an Energy Monitoring package shall be carried out at the management level. When sharing alarm and historical information with Maintenance Management and Energy Management packages, the management system shall provide the information in a standard commercially available format e.g. MS Access and using standard mechanisms e.g. ODBC. Real-time “live” information shall be transferred form the management system to a third party package e.g. MS Excel, either by a standard inter-application mechanism e.g. DDE or OPC or by developing a connection by using a documented API for the management system. Where a physical connection is required between a 3rd party device and the management system, the sub-system supplier shall provide the necessary line drivers and cables, documentation and support to make the connection into the device that will provide the protocol conversion.

**Software Modules**

The management station software shall be modular; object oriented, clearly structured and shall be based on Windows 2000 and Windows XP (or later) standard 32-bit technology.
The main software applications shall, as a minimum, include:

- **Plant Viewer**: Graphics based operation of the plant
- **Trend Viewer**: Logging and display of measured values
- **Alarm Viewer**: Display of alarm messages
- **Alarm Router**: Automatic routing of alarms
- **Log Viewer**: Logging of alarms, system events and user activities

**The Task Bar**

The task bar shall be the 1st and last point of contact for all the interactions between user and system.

In addition to obtaining quick overview of vital system information, users shall be able to click on various icons in the task bar to switch from one program to another in the multi-tasking operating system. In systems, which include remote sites, the task bar shall be used to switch between sites (subject to user's access privileges).

To make the system easier for new users, the system shall support user-specific start-sequences with access to selected programs.

**Features of the Task Bar**

- Control of access privileges and security mechanisms for access to program modules and 3rd party software at login and log-out.
- User-and-password dependent access to systems and sub-systems
- Automatic user-specific start sequences
- Display of alarm and system message status, site connection status, time and date
- Facility to connect and terminate connection at various sites
- Simultaneous connection to a maximum of 4 sites

**Plant Viewer**

The plant viewer shall support the following features:

- Hierarchically linked, animated high-resolution bit-map colour graphics (XGA 1024 x 768 pixels)
- Choice of 2D and 3D symbols with animation based on status
- Direct access to set points, parameters, operating modes, alarms, time-programs, on-line and off-line trend data features
- Dynamic multi-tasking with all active pages
- Monitoring and operation of plant at several levels
- Flexible operation of multiple pages using plant viewer navigation bar combined with standard handling of windows
- Navigation to all other management station software applications
- User-definable page size
- Jump tags for jumps on the same level or between levels
- ToolTips for all dynamic objects, with the option of 'User', 'Technical' or 'System' information
- Context-specific information (eg. data sheets) can be attached to any dynamic object
- Capable of graphics to be printed in colour or monochrome
- All 32 bit graphic file formats supported by Windows can be imported (eg. AutoCAD, PCX etc.)
- Dynamic display of the Psychrometric chart, enabling easy simulation of the air-conditioning processes.

**Alarms Handling & Alarm Viewer**

As a minimum, the system shall support the following features:
• Operation and manipulation of alarms (based on user privileges)
• Alarm message printing
• Alarms printed independently of the management station (direct connection at automation level)
• Automatic pop-up windows for immediate display and operation of alarms (including pop-ups in 3rd party programs)
• Audible or multi-media alarm indication
• Continuous overview of all active alarms from site (updated automatically, displayed in order of priority, option of personalized view)
• Graphics based topological view of alarms
• Chronological alarm view
• Option of displaying detailed information
• Direct access to Associated plant graphics
• Comprehensive filter and search criteria (time, date, priority, discipline, alarm status etc.,)
• Colour coding based on alarm priority / alarm status (screen and printer)
• Alarms for out of limit values (high, low), change of state, run-time limits exceeded etc.
• Option of repeating unacknowledged alarms at regular intervals
• Creation of reports, with facility to print or export alarm data to 3rd party programs for further analysis
• Facility to save user-defined filter criteria
• User-specific configuration of the alarm view including on-line configuration

Alarm Routing

In order to monitor alarms round – the – clock, alarm routing is an important feature of the BMS. The BMS shall have the following features

• Routing of alarms to alarm printer, fax, pager or mobile phone
• Time schedule for each message recipient
• Alarm routing based on priority
• Alarm routing based on discipline (HVAC, Security etc.,)
• Alarms routing to person responsible at site
• Alarm routing based on text
• Alarm routing to person(s) responsible for specific equipment or systems
• Option of manual transmission of messages from the management system

Time Scheduling

The time-scheduler shall have the following features

• 7 day time programs
• Exception programs (local, building-wise or system-wise)
• Direct display of time programs within Plant viewer graphics
• Simple graphics programming of switch times
• Graphics based overview of all time programs in the system
• Graphics based overview of a 7 day programme including all exception programmes
• Graphics based overview of all plant points affected by a time programme
• Direct entry of various operating modes (comfort, stand-by, energy hold-off)
• Easy creation, modification and deletion of all time programmes
• Scroll features for fast access to specific weeks or days
• Storage and processing independent of management station
• Automatic synchronization of all time programmes in a system
• Support of different time zones (remote managed sites)
• Option of synchronization via radio clock
• Printed reports in various display forms
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Trend Viewer

The Trend Viewer shall have the following features

- On-line or off-line real-time data
- Simultaneous display of up to ten signals per window
- Absolute or relative time intervals
- Zoom, scroll and cursor features for faster data analysis
- Flexible, easy-to-use scaling feature with charts displayed in 2D or 3D
- Drag-and-drop feature for trend views with automatic scaling and data export
- Off-line data logging triggered manually, automatically, or on a time or event basis
- Logging and intermediate storage of off-line trend data operates independently of the management
- Automatic upload from automation level to local or remote management stations
- Management station display and archiving of on-line and off-line trend data
- Print-outs of trend data
- Easy export of data to 3rd party software
- Facility to export trend data directly to auxiliary programs such as ADP (Advanced Data Processing) or to 3rd party software such as MS-Excel
- Trend Viewer time base can be used directly as a filter creation in Log Viewer

Log Viewer

The Log Viewer shall be categorized into the following sections

ALARM LOG ➔ contains all incoming alarms in chronological order

SYSTEM LOG ➔ shows at a glance if a printer somewhere in the system has run out of paper, or a hard disk is full. Communication events are also recorded here, showing for example when communication was established or terminated

USER LOG ➔ lists all the activities carried out by the user at the management station, unauthorized attempts, modification of parameters, set points etc.,

STATUS LOG ➔ to check the status of all incoming messages

The Log Viewer shall have the following features

- Storage of alarms routed to the management station
- Storage of all system messages (from printer, communications, management station, modem etc.,)
- Storage of all user activities performed at the management station
- Facility to enter and store user comments on events and activities
- Facility to display, at a keystroke, detailed information on every entry
- Extensive filter options to focus and reduce the volume of information displayed
- Comprehensive search features for fast access to information
- Facility to display an overview of data for a given day or week
- Once defined, filter and search criteria can be saved for future re-use
- Compact archiving of virtually un-limited number of entries (depending on hard-disk capacity)
- Automatic data management and archiving functions
- Facility to create and print log summaries
- Export of log entries for further analysis with 3rd party software (eg –MS access)
- User specific configuration of log view can be adapted directly on line

Internet Log Viewer (Optional)

This is an optional application, which offers users even greater freedom in the management of a site. A browser such as Microsoft Internet Explorer or Netscape Navigator, for example, provides the user with access to the log database from any PC with an Internet connection. Just as with standard log
viewer, the user can then obtain an overall view of all the plant and events stored or monitored by the system.

The Internet Log Viewer shall be started without any special management station software on the user’s PC. Access to the Log Viewer can be password protected.

**A Web Control**

The system shall have the capability to connect to remote sites through a web control module. Individual DDC general-purpose communication trunks (described elsewhere) shall have the feature to be connected to this web control module. This should facilitate viewing and controlling the DDC general-purpose controllers trunk via a remote PC / laptop. All parameters as appearing in the Portable Operator Terminal (described elsewhere) shall be available from this remote PC / laptop. The system offered shall have the facility to control / monitor the plant and equipment connected to these communication trunks via password protection.

**Integration of 3rd Party Software and Exchange of Data**

The system shall support the use of standard interfaces and drivers that make it easy to integrate to 3rd party software directly at the management station level, or to make common use of data from the system, eg via ODBC (Open Database Connectivity). DDE (Dynamic Data Exchange) shall enable current data to be loaded continuously into a spreadsheet program such as MS Excel, so that constantly updated graphs can be created for further processing.

**Object Viewer**

To make operations easier, the software shall have two viewing modes.

- **System View** provides hierarchical view of the system network.
- **User Designation View** gives a hierarchical breakdown of user addresses based on the system database.

In general, the system shall support the following features:

- Fast navigation through the system
- Fast location of objects and alarms
- Detailed information of all objects
- Display of current values from the process level
- Modification of set points and parameters
- Users with appropriate access levels can also override outputs manually
- Two display modes: system view and user designation view
- Search features
- Jump features and bookmark features as in various internet browsers
- Modification of users designation and alarms texts
- Customization of users addresses with a maximum of 10 hierarchical levels and up to 40 characters
- “Find” function to locate system objects

**Reports**

Reports shall provide the user with the latest information from the system at specific times or when specific events occur. The following features shall be supported:

- Reports routed on basis of time and / or priority
- Manual or automatic triggering
- User-definable or standard reports
- Facility to integrate 3rd party report programs into the management station software
Access Protection

The management station shall grant access to the system only to authorized users. The system administrator shall tailor an environment to match the individual requirements of each user. The access protection facility shall define the buildings (sites) and equipment to which a given user has access, the software modules and functions available to that user within the site. The system shall support the following features:

- User name / password
- Individual access privileges covering access to sites, subsystems, program functions down to individual objects in Plant Viewer
- Up to 1000 users grouped into 100 user groups
- Automatic log – out (after period of inactivity)
- Encrypted passwords
- Network security provided by Windows NT access control

xiii. Hardware Requirements

DESKTOP COMPUTER

Processor : Pentium IV, 2.8 GHz
RAM : 256 MB
Hard Disk : > 40 GB
Graphics card : 1024 x 768 (XGA), > 2 MB memory
Monitor : 17”
Printer : 132 column, dot matrix, black & white
CD drive, multimedia kit, modem card

xiv. BACnet Routers

In addition to exchanging data with the management station and the other Controllers in the same network, a further capability of transferring non-critical, global data between DDC modules in different groups (i.e. on different buses).

The BMS offered must be capable of being extended with controllers on the BACnet protocol and the LON bus.

The BMS must allow integrating future BACnet controllers on the process level and providing inter-process communication with existing controllers.

The BMS must allow to be extended with controllers on the BACnet protocol and the LON Talk technology.

The BMS must allow for integration of BACnet devices on the process level via LON bus and on the management level via Ethernet TCP/IP.

xv. DDC LON network

This network shall allow the DDC modules to communicate with each other and provides the user with access via the operator terminal to all the connected DDC controllers.

The DDC controllers, wherever used, within the same enclosure, should be connected to each other via flat bus cable and it should have the DATA network cable between distant controllers.

Upto 30 DDC modules, and a maximum of 10 operator terminals may be connected to one DDC LON network.
Data must be kept even in the event of power failure. Power failures and peak loads must not cause data loss.

Permanent self-monitoring of the system must be ensured by integrated test and service functions.

Suitable interfaces and appropriate in/outputs must allow the integration of all electrical and mechanical plants.

xvi. Central setting of parameters/structuring and programming

It must be possible to enter and/or amend all parameters (setpoints, control algorithms, time, etc.) and the structure diagrams (control and interlock programs) into the lower levels system controllers and DDC units centrally from the management station and/or the operator terminal from the system controller with a download function. The system manager must be able to read and write all data centrally.

It must be possible to set the parameters and structure the application programs by using a graphic and element oriented programming language.

xvii. Portable Operator Terminal (POT)

Each DDC Controller shall have a dedicated service port to plug in the portable operator's terminal (POT). It shall be possible to read, write and change any parameters on a bus by plugging the POT to any one of the Controllers on the communication trunk. The portable operator's terminal shall have facility on its fascia. The POT shall have minimum three password levels. Separate cabling for connecting the POT shall not be acceptable. Changing the parameters locally from any Outstation shall be done by POT, which is truly portable, and hand held and not via Laptops.

A local operator terminal shall allow full operation of all DDC control modules connected to the LonTalk BACnet network. Functions to include:

- Alarm monitoring with acknowledgement and visual and audible alarm indication.
- Pop up window with detailed message for alarms and events
- Alarm and event history
- Data point display and operation of all measured values, setpoints, plant states, operating states and parameters
- Graphic based display and operation of all time schedules, exception calendar, online trending and heating curve.
- User specific configurable overview of main values in plant
- Multi user level access protection

The operator terminal shall have a high resolution six line illuminated display for graphics and text, keys for operation and a visual and audible common alarm indication. The textual information displayed must reflect the layout of building and plant with clear text English descriptions of up to 40 characters.

xviii. Documentation

In order to have clear system documentation, the following documents have to be provided:

- System diagram
- Wiring diagram
- Lists of parameters

For hand-over all documents must be up to date and provided with the date.

xix. Services
The type and scope of the required services are described below.

The rates for engineering, commissioning and adjustment must contain all services required to ensure optimum operation of the plants.

xx. Engineering/Planning

In addition to the required, complete documentation, the service must include:

- Analysis of all functions together with the contractor
- Binding information about conditions of connection of equipment
- Scheduling and co-ordination with the contractor and design engineer

xxi. Commissioning/Adjustment

Function-oriented commissioning includes the following services, which are to be provided by BMS specialist:

- Verification of the external connections of the equipment
- Verification of the data transfer channels of the system
- Loading and testing of all basic and user programs belonging to the equipment
- Optimisation of the control parameters

xxii. Electric & Electronic Related Equipments

Ambient Conditions

All controls shall be capable of operating in ambient conditions varying between 0-40°C and 90% r.h. non-condensing.

Conduit Entry

All control devices shall, unless provided with a flying lead, have a 20 mm conduit knockout. Alternatively, they shall be supplied with adapters for 20 mm conduit.

Ancillary Items

When items of equipment are installed in the situations listed below the BMS/Control Specialist shall include the following ancillary items:

Weather Protection

All devices, which are exposed to the atmosphere, are to be weatherproofed. All controls, peripherals and associated accessories serving Chillers, Roof Mounted Air Handling Units and other equipment, which are exposed, shall be protected from Dust, Rain and Solar Radiation. Adequate protection shades etc., shall be provided by the MEP contractor.

Pipe work Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed 1/2" or 3/4" BSPT suitable for the temperature, pressure and medium.

Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, lock nuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device, shall be provided by the MEP contractor.

Samples
Samples of all types of room mounted equipment (i.e. detectors, thermostats, etc.) shall be provided by the BMS/Controls Specialist for approval by the Consultant/Engineer.

Accuracy

Control and measuring devices shall have the following limits of accuracy:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>+/- 1°C over the range of 0°C to 50°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>+/- 1.5% of measured value</td>
</tr>
<tr>
<td>Humidity</td>
<td>+/- 5% RH over the range of 10 to 90% r.h.</td>
</tr>
</tbody>
</table>

Averaging Elements

Averaging elements shall be used on supply air ducts having a cross-sectional area exceeding 1.6m² and shall have a minimum capillary length of 8.2 m.

The capillary element shall be serpentined across the whole duct.

Where the span of the element is less than 1 m then it shall be fixed with purpose-made clips and may be unsupported across the duct.

Where the span of the element is above 1 m then it should be supported on Unistrut or similar rigid support. The element shall be clipped every 200m and the supports and hangers shall be adequate to prevent vibration of the element.

Pressure switches for Air Systems

Pressure switches for Air Systems shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Airflow proving, dirty filter, etc. The setpoint shall be concealed type. The contact shall be SPDT type with 250 VAC, 1A rating.

Shall be supplied suitable for wall mounting or mounting on ducts in any plane. It should be mounted in such a way so that the condensation flow out of the sensing tips. Proper adapter shall be provided for the cables.

The setpoint shall fall within 40%-70% of the scale range.

Shall have differentials adjustable over 10%-30% of the scale range.

Air flow Switches

The Airflow switches shall be selected for the correct air velocity, duct size and mounting altitude.

Where special atmospheric conditions are detailed in the Motor Control Panel Equipment Schedules, the parts of the switches shall be suitably coated or made to withstand such conditions. Any variations from standard shall be detailed in the Tender.

Shall be suitable for mounting in any plane.

Water flow switches

Water flow switches shall be selected for the correct water velocity and pipe size and mounting attitude.
xxvii. **Room Temperature / Humidity Detectors**

The temperature sensor shall have sensitivities such that a change at the detector of 0.2°C from the stabilised condition is sufficient to start modulating the corrective element.

The temperature sensor shall be with silicon/ Ni sensor. The sensor shall be field wired using an unscreened cable to a base plate. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The protection standard shall be IP42/IP54 in accordance with IEC 529. These should be generally mounted 1.5 m above the floor level. These should not be mounted near the heat sources such as windows, electrical appliances, etc. The final location shall be as per the consulting engineers’ approval. The sensor shall be linear over 0°C to 50°C.

Shall operate on extra-low voltage and be suitable for mounting on British Standard conduit boxes.

The humidity sensor shall be in an independent housing or be combined with the room/duct type temperature sensor in the common housing. The sensor should be electronic type with capacitive sensing element. As a minimum it should have a range of 10 to 90% RH.

xxviii. **Immersion/temperature detector and duct mounted temperature / humidity detectors**

The temperature sensor shall have sensitivities such that changes at the detector, for 0.3P°C and 0.2P°C respectively, from the stabilised conditions, are sufficient to start modulating the corrective element.

The humidity sensor shall be in an independent housing or be combined with the room/duct type temperature sensor in the common housing. The sensor should be electronic type with capacitive sensing element. As a minimum should have a range of 5 to 95% RH & 0-35 Deg C for temperature.

The temperature sensor shall be with silicon/ Ni sensor. The sensor shall be field wired using an unscreened cable to a base plate. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The protection standard shall be IP54 in accordance with IEC 529.

The wiring terminals shall be plug-in type for easy installation and maintenance. The sensor shall be mounted in the duct based on the guidelines given by the specialist control supplier. The sensor shall be linear over 0°C to 50°C.

xxix. **Pressure Detectors (for Liquids and Gaseous Media)**

Pressure detectors shall be suitable for the suitable for the medium and the working temperatures and pressures. The pressure detector shall be capable of withstanding a hydraulic test pressure of 2 times the working pressure.

Connections shall be suitable for 1/2 to 1/8" in O.D. copper tube.

Ductwork versions shall be supplied with the air connections permitting their use as static or differential pressure detectors.

The setpoint shall fall within 40%-70% of the sensing range of the detector.

The detector shall have sensitivity such that a change of 1.5% from the stabilised condition shall cause modulation of the corrective element.

The static pressure sensor shall be rated for IP65 and the differential pressure sensor shall be as a minimum IP54.
The principle of operation should be based on a hall-effect transducer. The diaphragm should be copper beryllium type.

The sensor must be pressure compensated for a medium temperature of -10 to 80°C with ambient ranging between -25 to 60°C.

**Air Pressure sensor:**

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive coupling, which would electro magnetically give an output suitable for the controller. The pressure sensor shall in a housing having IP54 ratings in accordance with IEC529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes, probes, etc.

**Actuators**

Shall be installed in accordance with the manufacturers' recommendations.

Shall have a sufficient torque to open and close valves and dampers against the maximum out of balance pressure across them.

**Control Damper Actuators**

Control Damper Actuators shall be of the type where the damper spindle passes through the actuator and is secured by a U clamp.

Rotary type damper actuators shall be used on the project. The actuators shall not require any maintenance. The actuators shall have sufficient torque ratings to operate the dampers of various sizes.

These should be available in spring return versions as specified elsewhere in the document. Limit switches, if required/specified shall be provided for.

The actuators shall be suitable for On/Off and modulating operations.

**Actuator Additional features**

Actuator Additional features are required when detailed in the Motor Control Panel Equipment Schedules or the Performance Section of the Specification.

**Auxiliary Switches:**

For On/off applications, the actuators shall have changeover contacts suitable for 220 VAC. 2 amp rating.

Auxiliary switch packs containing at least one, if specified two, electrically independent switches one for each end of the motor travel, adjustable for operation over at least half the motor travel.

**Feedback signal**

0 to 10 V dc. signal should be available from the modulating damper actuator for parallel operation or as feedback. Please refer the data point schedules / sequence of operation/ drawings to incorporate this feature wherever asked for.

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**Control Valves (Modulating)**
General

All control Valves with KV lesser than or equal to 4 shall have RG5 gunmetal / red bronze body. Actuators shall be PWM or 0-10v dc modulating motor type or 3 point reversible motor type. PWM actuators shall be used in conjunction with controllers having in-built PID algorithm.

Control Valves with KV = 6.3 shall have RG5 gunmetal / red bronze body. Actuators shall be 3 point reversible motor type or 0 – 10 V dc modulating motor type. Actuators shall have manual override hand-wheel.

Control valves with Kv >6.3 shall have RG5 gunmetal / CI. Actuators shall be magnetic / or 0 – 10 V dc modulating motor type. Actuators shall have manual override hand-wheel.

Valves up to including 40 mm shall be rated for 16 bar Nominal Pressure. Valves for 50 mm and above shall be rated for nominal pressure of 10 bar, provided the operating pressure of the system is not greater than 6 bar. Valves above 100 mm shall be rated for 16 bar Nominal Pressure and actuators shall for these valves be magnetic / electro–hydraulic / motoric working a 0-10v DC modulating signal. Actuators for valves 100 mm dia and above shall have spring return feature as well as manual override hand-wheel.

All valves 15mm and above shall have rangeability > 100.

Authority

All 3 port modulating valves shall be selected to have an authority between 0.4 and 0.68.

For systems using 2 port modulating valves, the MEP contractor shall furnish the controls’ supplier details such as Pressure drop across the index circuit based on which the pump head was calculated, the pump head calculation, the design head of the pump ordered for the project, the available pressure on the system and the nodal pressures on each branch circuit of each AHU / FCU. Based on these data, the controls’ supplier shall submit the working principle for valve selection.

Butterfly Valves

Butterfly valves shall be manufactured by the Controls Manufacturer or alternative, approved by the Consultant / Engineer.

Occupancy Detector

The occupancy detector should be microprocessor based passive infrared detector for control of lighting equipment and VAV boxes in the room. The detector shall operate at 230VAC and will give a potential free output of minimum rating of 2 amps at 230VAC for control of lighting and VAV boxes for maximum energy savings and demand dependant controls. It should have an adjustable switch on delay of minimum 0…300 sec and an adjustable switch off delay of minimum 0.5…30 minutes. The detector should cover a minimum zone of 6 X 12 meters. The detector should be capable of detecting a moving infrared source. It should be optimized to detect the low level of sedentary workers. The detector should have minimum sensitivity of 50cm physical movements. The detector should be minimum IP50 with CE conformance.

BTU Meters:

The flow meter used in the above meter should be based on the ultrasonic principle with no moving parts. The temperature sensors used in the above meter should have a measuring range of 0…130 deg C with a resolution of 0.1 deg C. The BTU meter should have a built in minimum 8 digit LCD display for display of parameters, values and faults. The meter should be compatible with the BMS system. The minimum functions to be provided by the BTU meter is as under:
• Calculation and storage of maximum values
• Storage of billing data
• Measurement of tariff dependent data
• Storage of 13 monthly cumulative energy/volume values in EEPROM.
• Detection of faults
• Display of values, parameters and faults
• Selectable scope of display
• Test and service functions.

The BTU meter should have a minimum sampling time for flow every 3 seconds and temperature 24 seconds. Possible displays to be indicated are KWH, MWH, GJ, MJ, KW, m3, m3/hr, h and Deg C. The heat meter should have a minimum accuracy of class 2 with CE conformance.

xxxiii. **DDC Panels**

The out-station panel housing the DDC controllers shall be located inside the conditioned area. Proper care shall be taken to ensure that there is no induction problem between the control and power cables. These panels shall be IP54 and supplied by the specialist controls supplier.

The DDC controllers located inside these out-station panels shall provide the required signals to the various equipments connected to these DDC controllers. The DDC controllers shall be capable of accepting digital input signals in the form of volt-free contacts from Motor control centres. The MEP contractor shall co-ordinate this activity.

All these outstations shall be connected with a communication bus cable and terminated to the BMS central station. The BMS supplier shall supply these bus cables.

It should be possible to connect the Portable hand held terminal to be connected to any of these panels and talk to any other DDC controllers on the same bus.

**Note:** After award of the work, AC contractor is requested to prepare the I/O summary based on the GFC Drwg. issued by the respective consultant and submit it for approval to us. AC Contractor shall have to coordinate with all services consultant.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description / Ranges</th>
<th>Function</th>
<th>Qty</th>
<th>AI</th>
<th>DI</th>
<th>AO</th>
<th>DO</th>
<th>Monitor</th>
<th>Control</th>
<th>Alarm</th>
<th>By IBMS provider</th>
<th>By respective trade contractors</th>
<th>Benefit / purpose</th>
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<td>7</td>
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<td>By respective trade contractors</td>
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</table>

- **Start/ Stop Chiller On / Off command**: Wiring & termination at Chiller microprocessor accepting (2 amp. NO contact) remote start / stop. For automatic Chiller Operation based on schedule / condition - optimizes energy consumption.
- **On / Off Chiller Run Status**: Wiring & termination of Potential Free NO contact at the microprocessor panel. Monitoring / Alarm information, also utilized in Chiller sequencing.
- **Local - Remote Chiller local / remote status**: Wiring & termination of Potential Free NO contact at the microprocessor panel. Input information for command functions & interlocks.
- **Normal / Tripped Chiller Trip / Fault status**: Wiring & termination of Potential Free NO contact at the microprocessor panel. Monitoring / Alarm information, also utilised in Chiller sequencing.
- **Deg C Chilled water supply header temperature**: Installation in suitably sized socket in the chilled water line. Derive tonnage information, also for CHW leaving temp. reset.
- **Deg C Chilled water return header temperature**: Installation in suitably sized socket in the chilled water line. Derive cooling demand of the building.
- **USGPM Chilled water return header flow rate**: Installation in suitably sized socket in the chilled water line. Derive cooling demand of the building with flow & header temp.
<table>
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<tr>
<th>S. No.</th>
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<th>Benefit / purpose</th>
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<tbody>
<tr>
<td>8</td>
<td>Deg C</td>
<td>Chilled water outlet supply temperature at each chiller</td>
<td>3</td>
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<td></td>
<td></td>
<td></td>
<td>Immersion temperature sensor with thermowell</td>
<td>Installation in suitably sized socket in the chilled water line</td>
<td>Monitoring information, also for use in CHW leaving temp. reset</td>
</tr>
<tr>
<td>9</td>
<td>Open / Close</td>
<td>Chiller isolation valves open / close command</td>
<td>3</td>
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<td></td>
<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
<td>Wiring &amp; termination at motorised butterfly valve at CHW supply line to accept 1 SPDT for opening and closing of valves.</td>
<td>For sequencing (or isolation) in case of multiple chiller system - Major energy saving feature</td>
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<tr>
<td>10</td>
<td>Open / Close</td>
<td>Chiller out valves open / close status</td>
<td>6</td>
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<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
<td>Wiring &amp; termination at motorised butterfly valve at CHW supply line with provision of separate potential free NO contacts for open and close status</td>
<td>Input information for command functions &amp; interlocks</td>
</tr>
<tr>
<td>11</td>
<td>Open / Close</td>
<td>Condenser isolation valves open / close command</td>
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<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
<td>Wiring &amp; termination at motorised butterfly valve at CDW supply line to accept 1 SPDT for opening and closing of valves.</td>
<td>For sequencing (or isolation) in case of multiple chiller system - Major energy saving feature</td>
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<tr>
<td>12</td>
<td>Open / Close</td>
<td>Condenser out valves open / close status</td>
<td>6</td>
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<td></td>
<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
<td>Wiring &amp; termination of motorised butterfly valve at CDW supply line with provision of separate potential free NO contacts for open and close status</td>
<td>Input information for command functions &amp; interlocks</td>
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<td>S. No.</td>
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<td>13</td>
<td>Chiller microprocessor (software) integration for Chiller intrinsic parameter monitoring</td>
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<td></td>
<td>INTEGRATOR UNIT / Software connectivity on DDC field bus</td>
<td>Networked Chiller microprocessors releasing information at one port on ASHRAE defined BACnet TCP/IP Open protocol or LONWorks Open Protocol.</td>
<td>Provide comprehensive Chiller information on BAS user interface, perform trend &amp; archive functions</td>
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<tr>
<td>14</td>
<td>% RH Outside air relative humidity monitoring</td>
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<td>Outside Air RH Sensor</td>
<td>Wiring &amp; installation of Outside air sensor</td>
<td>Monitoring points for global functions</td>
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<td>15</td>
<td>Outside air temp monitoring</td>
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<td>Outside Air Temp Sensor</td>
<td>Wiring &amp; installation of Outside air sensor</td>
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<td><strong>Primary Chilled Water Pumps</strong></td>
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<td>Start/ Stop Chilled Water Pump on / off command</td>
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<td>Relay output @ 2 amp, 230 V</td>
<td>Wiring and termination of potential free contact in auto mode in the control circuit</td>
<td>For automatic pump Operation based on schedule / condition - (ensures equal run-time)</td>
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<td>Auto- Manual Chilled Water Pump auto manual status</td>
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<td>Wiring &amp; termination at auxiliary potential free contact of auto manual switch</td>
<td>Input information for command functions &amp; interlocks</td>
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<td>On / Off Chilled water Pump run Status</td>
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<td>Current relay</td>
<td>Wiring &amp; Installation of current relay in MCC panel (cable alley)</td>
<td>Proof of pump running - interlock function</td>
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## Construction of Medical College & Hospital Sundargarh, Orissa

<table>
<thead>
<tr>
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<td>Start/ Stop</td>
<td>Condenser Water Pump on / off command</td>
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<td></td>
<td>Relay output @ 2 amp, 230 V</td>
<td>Wiring &amp; Termination of potential free contact in auto mode in the control circuit</td>
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<td>By respective trade contractors</td>
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<td>Relay output @ 2 amp, 230 V</td>
<td>Wiring and termination of potential free contact in auto mode in the control circuit</td>
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<td>Relay output @ 2 amp, 230 V</td>
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<td>Proof of CT Fan running - interlock function</td>
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<td>Low / normal Cooling Tower sump water level</td>
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<td>Suitably sized socket for installation of level switch</td>
<td>Monitoring &amp; Alarm information - other alerts / interlock functions</td>
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## CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

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<tr>
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<th>By respective trade contractors</th>
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<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
<td>Wiring &amp; termination at motorized butterfly valve at CT line to accept 1 SPDT for opening and closing of valves.</td>
<td>For sequencing (or isolation) in case of multiple CT system - energy optimization function</td>
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<td>CT inlet isolation valves open / close status</td>
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<td>*</td>
<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
<td>Wiring &amp; termination of motorised butterfly valve at CT line with provision of separate potential free NO contacts for open and close status</td>
<td>Input information for command functions &amp; interlocks</td>
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<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
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<td>Relay output (1 SPDT for open and close) @ 2 amp, 230 V</td>
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## HOT WATER GENERATOR

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<th>By respective trade contractors</th>
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<td>Start/ Stop</td>
<td>Hot Water Generator On / Off command</td>
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<td>Relay output @ 2 amp, 230 V</td>
<td>Wiring &amp; termination at Chiller microprocessor accepting (2 amp. NO contact) remote start / stop</td>
<td>For automatic Chiller Operation based on schedule / condition - optimises energy consumption</td>
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<td>Deg C Hot water supply header temperature</td>
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<td>Immersion temperature sensor with thermowell</td>
<td>Installation in suitably sized socket in the chilled water line</td>
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<td>6</td>
<td>Deg C Hot water return header temperature</td>
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<td>Flowmeter</td>
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<td>Deg C Hot water outlet supply temperature at each Generator</td>
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## Hot Water Generator

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<tr>
<td>9</td>
<td>Open / Close Hot Water Generator isolation valves open / close command</td>
<td>Relay output (1 SPDT for open and close) at 2 amp, 230 V</td>
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<td>Wiring &amp; termination at motorised butterfly valve at CHW supply line to accept 1 SPDT for opening and closing of valves.</td>
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<td>Wiring &amp; termination of motorised butterfly valve at CHW supply line with provision of separate potential free NO contacts for open and close status</td>
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### Sub Total for Hot Water Generator

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## Variable Speed Hot Water Pumps

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<td>Wiring and termination of potential free contact in auto mode in the control circuit</td>
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## VSPS Microprocessor (Software) For Integration / Parameter Monitoring

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<td>Networked VSPS Microprocessors sharing information at one port on defined BACnet TCP/IP Open protocol</td>
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<td>Provide comprehensive VSPS information on BAS user interface, perform trend &amp; archive functions</td>
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## Sub Total for Variable Speed Hot Water Pumps

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### B - AHU

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<td>Relay output @ 2 amp, 230 V</td>
<td>Wiring &amp; termination of potential free contact in auto mode in the control circuit</td>
<td>Automatic AHU Operation on schedule / condition - based controls</td>
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<td>Wiring &amp; termination of auxiliary potential free contact of auto manual switch</td>
<td>Input information for command functions &amp; interlocks</td>
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<td>Diff. Pressure Switch - Air</td>
<td>Insertion provision for Installation of DP switch across blower</td>
<td>Proof of AHU running - interlock function</td>
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<td>On / Off AHU Pre filter status - Supply Side</td>
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<td>Diff. Pressure Switch - Air</td>
<td>Insertion provision for Installation of DP switch across filter</td>
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<td>Deg C Return air temperature monitoring</td>
<td>49</td>
<td>*</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Wall / Duct mount temp sensor</td>
<td>Installation provision for temp. sensor</td>
<td>Input information for valve command functions</td>
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### CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

#### Table: Air Handling Units

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description / Ranges</th>
<th>Function</th>
<th>Qty</th>
<th>AI</th>
<th>DI</th>
<th>AO</th>
<th>DO</th>
<th>Monitor</th>
<th>Control</th>
<th>Alarm</th>
<th>By IBMS provider</th>
<th>By respective trade contractors</th>
<th>Benefit / purpose</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>% Open</td>
<td>CHW &amp; HW modulating valve control</td>
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<td>Major energy saving feature - optimises CHW consumption</td>
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<td></td>
<td>Sub Total for Air Handling Units</td>
<td>49</td>
<td>165</td>
<td>67</td>
<td>49</td>
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<tr>
<td>C</td>
<td>FANS / AWS / Scrubber</td>
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<td>1</td>
<td>Start/ Stop</td>
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<td>Relay output @ 2 amp, 230 V</td>
<td>Wiring &amp; termination of potential free contact in auto mode in the control circuit</td>
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<td>2</td>
<td>Auto- Manual</td>
<td>Axial / Centrifugal / AWS / Scrubber fan on / off command</td>
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<td></td>
<td></td>
<td></td>
<td>Wiring &amp; termination of auxiliary potential free contact of auto manual switch</td>
<td>Input information for command functions &amp; interlocks</td>
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#### Table: S. No. 3 Description / Ranges

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description / Ranges</th>
<th>Function</th>
<th>Qty</th>
<th>AI</th>
<th>DI</th>
<th>AO</th>
<th>DO</th>
<th>Monitor</th>
<th>Control</th>
<th>Alarm</th>
<th>By IBMS provider</th>
<th>By respective trade contractors</th>
<th>Benefit / purpose</th>
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<tr>
<td>3</td>
<td>On / Off</td>
<td>Axial / Centrifugal / AWS / Scrubber fan on / off command</td>
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<td></td>
<td>Current relay</td>
<td>Wiring &amp; Installation of current relay in MCC panel (cable alley)</td>
<td>Proof of fan running - interlock function</td>
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<tr>
<td>4</td>
<td>Start/ Stop</td>
<td>Lift / Staircase Pressurization fans on / off command - Test Run</td>
<td>20</td>
<td>20</td>
<td>*</td>
<td>Relay output @ 2 amp, 230 V</td>
<td></td>
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<td>Wiring &amp; termination of potential free contact in auto mode in the control circuit</td>
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<td></td>
<td>Automatic fans Operation on schedule / condition - based controls</td>
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<tr>
<td>5</td>
<td>Auto- Manual</td>
<td>Lift / Staircase Pressurization fans auto manual status</td>
<td>20</td>
<td>*</td>
<td>*</td>
<td>Wiring &amp; termination of auxiliary potential free contact of auto manual switch</td>
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<td>Input information for command functions &amp; interlocks</td>
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<tr>
<td>6</td>
<td>On / Off</td>
<td>Lift / Staircase Pressurization fan run status</td>
<td>20</td>
<td>*</td>
<td>Current relay</td>
<td>Wiring &amp; Installation of current relay in MCC panel (cable alley)</td>
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<td></td>
<td>Proof of fan running - interlock function</td>
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</tbody>
</table>

Sub Total for fans 0 220 0 20

GRAND TOTAL 57 385 67 69 Provision 125 Points

END OF BMS SPECIFICATION
xiv) Variable Air Volume Unit

i. Scope

A. This section covers the construction and installation of variable air volume boxes Associated with the air conditioning systems indicated on the drawings.

ii. General

B. The design, construction, materials and finishes of all units shall be suitable for the locations, climatic and operating conditions indicated in this specification and drawings.

C. Boxes shall be single duct variable volume pressure independent type.

D. Each VAV unit shall consist of Thermostat, Control and Power Wiring, Insulated Casing etc

iii. Construction

A. The VAV terminals shall be made of minimum 0.8 / 1.00 mm galvanized steel sheet internally lined with engineered polymer foam insulation which complies to UL 181 and NFPA 90A or lining as specified in BOQ. Closed cell foam insulation shall be of minimum 22-24 Kg/cumtr. Density.

B. The 24 V, 50 Hz power source shall energise and operate each VAV box.

C. Actuators, reset controllers, circuitry, and distribution boxes shall be provided and installed at the factory and must be integrated into the unit casing. The control equipment must be easily accessible through an access door provided with quick release frames.

E. The controller shall be preset at the factory for specified maximum and minimum air flow rates.

F. The volume control linkage shall be calibrated to identify air volume in increments of percent of air flow from minimum to maximum air flow.

G. The unit shall allow for adjustment to air flow limits on site for future change. Provision shall be made for calibration and resetting on site by:

1. External gauge tappings
2. Dials on the controller
3. Thermostat adjustment

H. Each unit shall be supplied complete with a fully site resettable controls calibration chart for setting of air flow on site. This shall be attached to the unit.

I. The room thermostat shall be electronic digital type and mounted as defined in the Particular Specification.

J. Volume dampers or valve and controls shall be run test, sequence of operation checked and air volume limit preset, prior to shipment.

K. Air distribution boxes shall be fitted to the units according to the layout indicated on the drawings and details.
iv. Installation

A. Install air terminal units in positions shown on drawings.

B. Align and level all units.

C. Fix all units to wall, floors or supports as shown on drawings.

D. Ensure adequate space is available around the units to allow inspection and maintenance of all components in accordance with manufacturers recommendations.

E. Co-ordination of air terminal location shall be made with the ceiling pattern, to ensure easy access in the future.

F. Manufacturers recommendations on installation shall be followed.

v. Commissioning

A. Carry out static check on unit, settings of controls and electrical connections to ensure conditions are safe prior to start up.

B. Operate units to ensure all control components and switches function correctly.

xv) Pressurized Expansion Tank & Air Separator

i. Scope of Work

This section deals with supply, erection, testing and commissioning of pressurized expansion tank & air separator for chilled water conforming to general specification and suitable for the duty selected as indicated in BOQ.

ii. Pressurized Expansion Tank

Expansion tanks shall be ASME rated pre-charged bladder type pressure vessels. Expansion tanks shall be designed to absorb the expansion forces of heating/cooling system water while maintaining proper system pressurization under varying operating conditions. The heavy duty bladder shall contain system water thereby eliminating tank corrosion and water logging problems. Tanks shall be factory pre charged at 12 psi. Sight glass and seismic restraints shall be available on request. Bladder material shall be Heavy Duty Butyl Rubber. System connections shall be of Forged Steel. Tank’s shell shall be of Carbon Steel. Tank’s maximum operating design pressure shall be 125 psi. Tank’s maximum operating design temperature shall be 240°F. The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. The tanks can be installed in the horizontal position with the system connection located below the horizontal centerline of the tank.

iii. Air Separator
Furnish and install, as shown on plans, a centrifugal type air separator. The unit shall be (NPT/flanged/grooved) inlet and outlet connections tangential to the vessel shell. The unit shall have an internal stainless steel air collector tube with 5/22" (4mm) diameter perforations and 63% open area designed to direct accumulated air to the compression tank on an air control system or an air vent on an air elimination system via an NPT vent connection at top of unit.

Vessel Shell diameter is to be three times the nominal inlet/outlet pipe diameter, with a minimum vessel volume for sufficient velocity reduction. The air separator must be designed, constructed and stamped for 125 psig @ 3500 F (862 kPa @ 1770 C) in accordance with Section VIII, Decision I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. The air separator(s) shall be painted with one shop coat of light gray air dry enamel.

A manufacturer’s Data Report for pressure Vessels, form U-1 as required by the provisions of the ASME Boiler and pressure Vessel Code, shall be furnished for each air separator upon request.

C) TECHNICAL SPECIFICATION FOR ELECTRICAL ITEMS

i) Electrical Motors

i. Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of all types of motors used for HVAC Units conforming to these specifications and in accordance with Schedule of Quantities. The motor installation, wiring & its control shall be carried out in accordance with the specifications as detailed below.

ii. Motors

The motor shall be of the following design and should run at all loads without any appreciable noise or hum.

**Totally enclosed fan cooled Sq. Cage.**

Enclosure and type of motor shall depend upon duty and usage unless otherwise specified.

a) The winding of motors shall be class ‘B’ insulation and suitable for local conditions. The insulation of motors shall confirm to IS:325/1978.

b) All motors shall comply with IS:325, IEC-34.1 or BS – 2313, IEC-72.1 for foot mounted motors.

c) The rating of the motor shall be as indicated in the Schedule of Quantities. The motors shall be selected on the basis of ambient temperatures and allowable maximum temperature rise.

d) Motor above 1HP shall be three phase unless otherwise specified.

e) All motors shall be rated for continuous duty as per IS:325. Motor shall be suitable for operation on 415 volts ± 10% volts, 50 ± 5% Hz three phase AC supply (or 230 ± 10% volts, 50 ± 5% Hz for single phase AC supply).

f) Motors shall be provided with cable box to receive Aluminum conductors, PVC insulated, PVC sheathed and armored cables.

g) All motors shall be provided with combination of ‘Ball and Roller Bearing’. Suitable grease nipples for regreasing the bearing shall be provided.
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

h) Motors above 0.25 HP shall be provided with overload protection. Motors above 100 HP shall be provided with thermal protection and thermistor detector in the stater winding.

i) The starter current and the type of starter to be used shall be as follows (unless otherwise specified)

<table>
<thead>
<tr>
<th>Type of motor</th>
<th>Starting Current</th>
<th>Starting method</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Sq. Cage motor up to 7.5 HP</td>
<td>600% of full load current</td>
<td>D.O.L</td>
</tr>
<tr>
<td>b) Above 7.5 HP up to 60 hp</td>
<td>250% of full load current</td>
<td>Star / Delta</td>
</tr>
<tr>
<td>c) 75 HP &amp; above</td>
<td>200% of full load current</td>
<td>Closed transition Star / Delta or Double Star</td>
</tr>
</tbody>
</table>

iii. Motor Starters

a) All starter shall confirm to IS: 13947. The starter shall be enclosed in sheet metal enclosure, which would be dust vermin proof.

b) All starter should have suitable range of voltage and frequency.

c) All starter shall have integral stop/start push button of international colour code.

d) Contactor shall have number of poles as required for appropriate duty. Contacts should be made of solid silver faced & shall be suitable for at least 40 contacts per hours.

e) In event of power failure, the starter should automatically disconnect.

f) All starters shall be provided with thermal over load relay.

g) All star delta starters shall have adjustable timers.

h) Terminal blocks with integral insulating barrier shall be provided for each starter.

i) All starters shall be provided as specified in Schedule of Quantities. All starter shall be compatible to the drive and driven equipment.

j) Extra contact for interlocking purpose shall be provided in the starter.

k) All starters shall be compatible for Auto / Manual operation (BMS Compatible)

l) All starters shall have separate single phasing preventer.

iv. Installation of Motors

a) The motor and drive machine shall be fixed on slide rails to facilitate belt and other adjustments.

b) Vibration isolation arrangement shall be provided.

c) The installation of motor shall be carried out as per IS: 900.

d) The motor with driving equipment shall be mounted on foundation and connected to each other with flexible coupling with guard in condenser & chilled water pumps.

e) All motor shall be wired as per specifications. Earthling of motor frame shall be done with GI strips as specified in ‘Schedule of Quantities’.
f) All motors shall be tested at manufacturer’s works as per I.S. standard and test certificates shall be furnished.

g) All motors after AC contractor shall test installation at site for vibrations, heating and electrical insulation resistance.

ii) Motor Control Centre, Ventilation Sub Panel, Power & Control Cabling, Earthing etc.

i. Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of Motor Control Centre, Ventilation Panels, AHU Sub Panel, power / control cabling & earthing work shall be carried out as per the specification given below and in accordance with Schedule of Quantities. All work shall confirm to Indian Electricity Act (amended up to date), I.S. code of practices, local rules and regulations etc. The codes & standard to be followed shall be as given below:-

- BIS 13947 (Part 4) - AC contactors up to 1000V
- BIS 13947 - AC Circuit Breakers
- BIS 2705 - Current Transformers
- BIS 3156 & 4146 - Potential Transformers
- BIS 4064 - Air break switches for voltage not exceeding 1000V
- BIS 13947 - Control switches
- BIS 1822 - Motor duty Switches
- BIS 12021 - Specification for control transformer
- BIS 8623 - Factory built assembly of switchgear & control gear
- BIS 13947 (Part I) - Degree of protection for enclosure
- BIS 3842 - Specification for electrical relays for AC system
- BIS 13707 - Specification for HRC fuses
- BIS 5082 - Wrought Al. and Aluminium alloys, bars, rods, tube and sections for electrical purposes
- BIS 13947 (Part I) - General requirement for switchgear & control gear for voltage not exceeding 1000V
- BIS 3231 - Electrical relays for power system protection

ii. Motor Control Centre / Ventilation Sub-Panel

Motor control centre shall be floor mounted extendable type bolted construction & Ventilation sub-panel shall be wall mounted type. The sheet steel (CRCA) used for fabrication shall be of 2.0mm for load bearing members and 1.6mm for non-load bearing members. The panels shall be supplied with required base channels. These panels shall be cubical sectionalized type, totally enclosed dust & vermin proof. Gaskets shall be provided in all joints to prevent dust to reach the internals of the panels to make it completely dust proof. The degree of protections for panels shall be IP 52 for indoor applications and IP 65 for outdoor applications as per IS:2147.

These panel (MV) shall be suitable for voltages up to 500 volts, three phase 50 Hz, 4 wire supply capable of functioning satisfactorily in temperature ranging up to 45 to 50 degree centigrade and rupturing capacity suitable for connected load & design should be type tested for 42 KA fault level. All joints of panels shall be welded and braced as necessary to provide a rigid support for all components. The base channel provided in the floor mounted MV panel shall be 100mm x 50mm x 6mm & a clear space of 200mm between the floor and the bottom most part of the unit shall be provided. The panel shall be correctly positioned. Self- threading screws shall not be used in the construction of control panels. Appropriate knock-out holes of proper sizes shall be provided for incoming and outgoing cables. The facility for bottom or top entry of cables in the panels shall be provided. Necessary cables clamps shall provided for holding the cables in position.
All power/control wiring inside the panel shall be colour coded and control wiring ferruled for identification purpose. All labeling shall be provided in engraved anodized aluminum strips on the front face of the panel.

Each circuit breaker shall be housed in separate compartments. It shall have steel sheets on top and bottom of compartment. The steel sheet hinged door shall be interlocked with the circuit breaker on the “ON” position. When the breaker is on the “ON” position, suitable preventive measures shall be provided, such as interlocks, to prevent the breaker from being drawn out. When the breaker is in “ON” position steel sheet shall be provided between the tiers in the vertical section. The door of this compartment shall not form part of the draw out arrangements.

iii. **Bus-Bars**

The bus-bar and its connections shall be aluminum Electrolytic grade E-91 as per IS: 5082 and shall be of rectangular section. These should be suitable for full load current for phase bus-bar and neutral bus-bar shall be of half rated current capacity. The bus-bar should have provision on either side for extension. The bus-bar should be sleeved with colour coded heat shrinkable PVC sleeve. Bus-bar supports shall be of fibre glass reinforced thermosetting polyester having in built and tracking barriers to break the path of conducting dust through moulded ribs.

In panels bus-bar connections shall be done by drilling holes with cadmium coated bolts and nuts. Extra cross section shall be provided to compensate drilling of the holes. Insulated aluminum strips of suitable size of full rated current capacity shall be used for interconnecting bus-bar and breaker.

A horizontal / vertical wire way shall be provided for interconnecting control wiring between different vertical sections.

The terminal blocks shall be used for outgoing terminals and neutral link at a suitable located place in the control panel. Separate compartments for outgoing and incoming cable shall be provided. The current transformers of all instruments shall be mounted with terminal blocks.

All live parts including incoming and outgoing link / terminals should be totally shrouded by means of non hygroscopic and fire retardant material.

iv. **Air Circuit Breakers**

The circuit breaker shall be capable of making and breaking the specified fault currents without straining or damaging any part of the switchgear. The breakers shall be air break, motorized / manually operated as specified in BOQ and draw out type. All feeders of rating 800A and above shall be ACB and of fully draw out type. The circuit breaker shall be stored energy closing type, manual/electrically operated with tripping mechanism. The circuit breaker shall be provided with 4 NO + 4 NC of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block. Circuit breakers with stored energy closing mechanism shall be capable of making the rated short-circuit current, when the stored energy is suitably charged by a spring. It shall also be capable of closing on no-load without suffering undue mechanical deterioration. The maximum make-time shall also not be exceeded.

The direction of motion of the handle, for manual spring charging shall be marked. A device indicating when the spring is charged fully shall also be provided. Motors and their electrically operated auxiliary equipment for charging a spring shall operate satisfactorily between 85% and 110% of the rated supply voltage. The breaker operating mechanism should store energy for O-C-O operation and shall not, in any case, get stuck in closed position during this cycle. After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible. The breaker operating mechanism shall be electrically and mechanically trip-free in all positions.

All ACBs shall be provided with microprocessor based trip unit for protection against overload, short circuit and earth faults. The releases shall be communicable to other systems on an open communication protocol. The Communication Port shall be provided in front/back. The circuit breakers shall be suitable for locking in fully isolated condition.
Following interlocks and features shall be provided so that

a) Truck can be moved within panel only when CB is off.
b) CB can be closed only when the test (or) service limit switches permits.
c) Breaker compartment door cannot be opened when the CB is in Service/test position.
d) Breaker cannot be put in to service position with compartment door open.
e) Earth slide beyond the test position till trolley is drawn out.

Closing and tripping coil shall operate satisfactorily under the following conditions of supply voltage variation:

a) Closing coils – 85% to 110% of rated voltage..
b) Trip coils – 70% to 110% of rated voltage.

v. **Moulded Case Circuit Breakers**

The MCCBs shall confirm to the latest applicable standards. MCCBs in AC circuits shall be of four pole construction arranged for simultaneous four pole manual closing and opening. Operating mechanism shall be quick-make, quick-break and trip free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. Operating handle for operating MCCBs from door of board shall be provided. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings. MCCBs shall incorporate time delay devices to ensure that it will tolerate harmless transient overload unless this is well in excess of 25% of its rated value for a sustained period. The circuit breaker shall be provided with 2 NO + 2 NC of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block. The breaking capacity of MCCB’s shall be as per the design requirements.

vi. **Miniature Circuit Breakers**

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 230/415 VAC 50 Hz applications 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 be 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. 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 and TPN miniature circuit breakers shall have a common trip bar.

vii. **Rotary Switch / Selector Switch / Switches / HRC Fuses / Starters / Single Phase Preventers / Toggle Switch**

These shall be of approved make and conforming to relevant ISI standard. The rupturing capacity of HRC fuses should not less than 80 KA and in case of switches it should be 60 Amps maximum.

viii. **Current Transformer**

The current transformers shall have accuracy of class I and 5P10 / 10P10 and suitable VA burden for operation of the connected meters and relays.

ix. **Overload Relays**

All the motors shall have overload relay protections conforming to relevant IS.
x. **Time Delay Relays**

These shall be adjustable type with time delay adjustments of 0-180 or as per manufacturers standards.

xi. **Indicating Lamps And Metering**

These shall confirm to BS37 & BS39. All meters shall be flush mounted and draw-out type. The indicating lamp shall be filament type and with very low burden & economy resistor.

xii. **Voltmeter And Ammeters**

Motor Control Centre (MV Panel) shall have flush type voltmeter & ammeter of size 96 x 96 mm.

xiii. **Push Button Stations**

These shall be suitable for panel mounting and accessible from front without opening. These shall be provided for manual starting and stopping of motors/equipments as per normal practices. The contacts shall be suitable for 6AMP current capacity.

xiv. **Name Plate**

Suitable anodized Aluminium name plate of 1.2 mm thick shall be provided on all the Switchboards and individual compartments.

xv. **Conduits**

These shall be preferable made of mild steel, stove enameled from inside and outside with minimum wall thickness of 1.6 mm for conduits up to dia of 25mm and 2 mm for conduits above 25 mm diameter.

xvi. **Cables**

Cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

The cables shall comply with the latest edition of the following standards

- BIS: 7098 (PART-I) - XLPE Cables - LT
- BIS: 8130 - Conductors for insulated electric cables & flexible cords.
- BIS: 3975 - Mild steel wires, strips & tapes for armouring of cables.
- BIS: 10418 - Wooden drums for electric cables.
- BIS: 10810 (PART 58) - Oxygen Index test

The material of cable shall be as follows:-

a) The MV power cable of 660/1100 V. grade shall be XLPE insulated Aluminium conductor armoured cable.

b) The MV control cables shall be PVC insulated copper conductor armoured stranded cable.

c) The HT power cable of 415 V grade shall be XLPE insulated Aluminium conductor armoured cable.

xvii. **Laying Of Cables**
These shall be laid as Indian Standard code of practice. All cables shall be laid on 16G GI Perforated U shaped Channel 40mm x 20mm cable trays. In case more than one cable is running, then proper space in between the two cables shall be provided to avoid loss of current carrying capacity. While cables are running on walls, proper saddles must be provided.

xviii. Wire Sizes

Single stand PVC-copper conductor wires shall be used inside the control panel for interconnecting different components. All wires shall be neatly dressed and coloured beads shall be provided for easy identification in control wiring. The minimum size of control wiring shall be 1.5sq.mm. Testing of panels as per code of practice shall be done at works by Employer / Architect before inspection & dispatch to site.

xix. Drawings

Necessary drawings of all control panels and wiring of equipment etc., shall be submitted by the contractor for approval of the Engineer in Charge. On final completion of job and before handing over of AC System As Built Drawings shall be submitted to the Department.

xx. Testing

All equipment and components supplied may be subjected to inspection and tests by the client / consultant or his authorized representatives during manufacture, erection / installation and after completion. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated. 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 client / consultant may reject the item, or defective component thereof, whichever he considers necessary.

The complete electrical installation shall be tested in accordance with relevant IS codes in presence of Electrical Supervisor of the client before commissioning of plant.

xxi. Painting Of Panels

All sheet metal enclosures shall be powder coated only after de-rusting & hot-dip phosphating degreasing etc. at works only.

NOTE: Rubber mats of 1100 volts shall be laid in front of all switch boards.

xxii. Sizes Of Power Cabling

The following size of power cabling shall be used only:

<table>
<thead>
<tr>
<th>HP of Motors</th>
<th>Cable size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Up to 5 HP</td>
<td>3c x 4sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>b) 5 to 7.5 HP</td>
<td>3c x 6sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>c) 10 to 15 HP</td>
<td>2no. 3c x 6sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>d) 20 to 25 HP</td>
<td>2 Nos., 3c x 16sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>e) 30 to 35 HP</td>
<td>2 Nos., 3c x 25sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>f) 40 to 50 HP</td>
<td>2 Nos., 3c x 35sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>g) 60 HP</td>
<td>2 Nos., 3c x 50sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>h) 75 HP</td>
<td>2 Nos., 3c x 70sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>i) 100 HP</td>
<td>2 Nos., 3c x 95sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>j) 125 HP</td>
<td>2 Nos., 3c x 120sq.mm aluminium conductor armoured cable.</td>
</tr>
</tbody>
</table>

xxiii. Capacity Of Relays And Contacts

The following capacity relays and contacts shall be used for various rating of motors:
The earthing of all equipments shall be carried out by Copper strips / wires as mentioned in Bill of Quantities. All panels / three phase motors shall be earthed with two number distinct and independent Copper strips / wires of the following sizes:

1. Motor upto 5.5 KW  
   3 sq. mm Copper Wire  
   4 mm dia GI Wire

2. Motor 7.5 to 18.75 KW  
   4 sq. mm Copper Wire  
   6 mm dia GI Wire

3. Motor 18.75 to 50 KW  
   25x3 mm Copper Strip  
   25x6 mm GI Strip

4. Motor 51 to 89 KW  
   25x6 mm Copper Strip  
   32x6 mm GI Strip

The earthing connections shall be connected to main earth station or main earth grid. The earth connections shall be connected to equipments after removal of paint, grease etc.
D) **SERVICES SPECIFICATION**

i) **Air Distribution**

i. **Scope of Works**

The scope of this section comprises supply, fabrication, installation & testing of all sheet metal GI ducts as well as supply, installation, testing & balancing of all grills, diffusers & other accessories in accordance with these specification & Schedule of Quantities.

ii. **GI Duct (Site Fabricated)**

a) All ducts shall be fabricated either from Galvanized Sheet Steel (GSS) conforming to IS: 277 or aluminum sheets conforming to IS:737. The steel sheets shall be hot dip galvanized with coating of minimum 120 grams per square meter (GSM) of Zinc.

b) The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

<table>
<thead>
<tr>
<th>Longest side (mm)</th>
<th>Minimum sheet thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For GSS</td>
</tr>
<tr>
<td>750 mm and below</td>
<td>0.63</td>
</tr>
<tr>
<td>751 mm to 1500 mm</td>
<td>0.80</td>
</tr>
<tr>
<td>1501 mm to 2250 mm</td>
<td>1.00</td>
</tr>
<tr>
<td>2251 mm &amp; above</td>
<td>1.25</td>
</tr>
</tbody>
</table>

c) All sheet metal connections, partitions and plenums required for flow of air through the filters, fans etc. shall be at least 1.25 mm thick galvanized steel sheets, in case of G.I. sheet ducting or 1.8 mm thick aluminium sheet, in case of aluminium sheet ducting and shall be stiffened with 25 mm × 25 mm × 3 mm angle iron braces.

d) Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended up to date.

e) Aluminium ducting shall normally be used for clean room applications, hospitals works and wherever high cleanliness standards are functional requirements.

iii. **Associated Items For Duct**

a) Jet nozzles/Eye ball suitable for long throw distance with optimum acoustic properties, preferably used for heating and cooling in critical areas. The adjustment facilities – manual or automatic. The adjustment can be rotated through 360°. The material of eye ball is aluminium and mounting for the eyeball is with two plastic rings colour white. The connection element and saddle connection are in galvanized sheet steel. The surface can be pre-treated and powder coated.

b) Supply/return air outlets F.A. grilles and accessories shall be constructed from extruded aluminium sections.

c) Flanges for matching duct sections, stiffening angels (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.

<table>
<thead>
<tr>
<th>Application</th>
<th>Duct Width</th>
<th>Angle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanges</td>
<td>Up to 1000 mm</td>
<td>35mm × 35mm × 3mm</td>
</tr>
<tr>
<td>-do-</td>
<td>1001 mm to 2250 mm</td>
<td>40mm × 40mm × 3mm</td>
</tr>
<tr>
<td>-do-</td>
<td>More than 2250 mm</td>
<td>50mm × 50mm × 3mm</td>
</tr>
<tr>
<td>Bracings</td>
<td>Up to 1000 mm</td>
<td>25mm × 25mm × 3mm</td>
</tr>
<tr>
<td>-do-</td>
<td>More than 1000 mm</td>
<td>40mm × 40mm × 3mm</td>
</tr>
</tbody>
</table>
d) Hanger rods shall be of mild steel and of at least 10 mm dia for ducts up to 2250 mm size, and 12 mm dia for larger sizes. All ducts shall be supported from the ceiling / slab by means of MS rods of dia (10-12) mm fully threaded with MS angle at the bottom with neoprene pad in between the duct & MS angle. The ducts shall be suspended from the ceiling with the help of dash fasteners. The contractor shall arrange provision for necessary ancillary materials required for hanging the ducts.

e) All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium – aluminium alloy. Self tapping screws shall not be used.

f) The vanes shall be provided wherever required and shall be securely fastened to prevent noise & vibration.

g) The rubber gasket shall be installed between duct flanges in all connections and joints.

h) All flanges and supports should be primer coated.

i) The flexible joints shall be fitted to the delivery side of AHU fans with Fire Retardant Double canvass. The length of flexible joints should not be less than 150 mm and not more than 300 mm between faces.

j) The ducting work can be modified if deemed necessary in consultation with the Engineer in Charge to suit actual site conditions in the building.

iv. Construction Of Duct

a) Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 “Specifications for metal air ducts”. Unless otherwise deviated in these General Specifications.

b) The interior surfaces of the ducting shall be smooth.

c) All the ducts up to 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 longest side, and 100 mm centres for ducts above 600 mm size shall be provided for stiffening.

d) As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.

e) Flanged joints shall be used at intervals not exceeding 2500mm. Flanged shall be welded at corners first and then riveted to the duct.

f) Stiffening angels shall be fixed to the sides of the ducts by riveting at 1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6 mm form joints for ducts of size larger than 1500mm. Bracings for ducts larger than 1500mm can alternatively be by diagonal angels.

g) Plenums for filters shall be complete with suitable access door of size 450mm × 450mm.

v. Box Type Dampers & Splitters
These dampers shall be provided in the ducting work for proper control and balancing of air distribution. All dampers shall be louver type robust construction. These dampers shall be fitted with easily accessible operating mechanism, complete with links, levers, quadrant for proper control and setting in a desired position. The position of the handle of the damper operating mechanism shall be clearly visible and shall indicate the position of the damper in the duct. All dampers, splitters shall be fabricated out of G.S. sheet of two gauges higher than the duct piece having these fittings. Dampers shall be installed in duct at all required locations. No extra payment shall be made separately since these form part of Air Circulation System.

NOTE: In case angle iron supports are not feasible to be installed for supporting the ducts due to height constraint then the contractor shall support the ducts with M.S flats of at least double the thickness of the angle iron supports.

vi. Supply / Return Air Grills & Ceiling Diffusers

Grilles and diffuser constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grills and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purpose.

All grills / diffusers shall have soft continuous rubber / foam gasket between the periphery of the grills / diffusers and surface on which it has to be mounted. The colour of grills / diffuser shall be as per the approval of the Engineer in Charge.

a) Rectangular / Square / Linear Supply And Return Grills

Square and rectangular wall outlets shall have a flanged frame with the outside edges retuned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give up to 22.5 degrees vertical deflection and adjustable back louvers parallel to the shooter side to achieve horizontal spread air pattern to at least 45 degrees. Fixed bar linear air grills shall have only front louvers. The outer framework to the grills shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8 mm at front and shall be made of 0.8 mm thick aluminium sheet. Louvers may be spaced 18 mm apart.

b) Square / Rectangular Ceiling Diffusers

Square and rectangular ceiling air diffusers shall have a flanged flush with the ceiling into which it is fitted or shall be of anti smudge type the outlets shall comprise and outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.

c) Circular Ceiling Diffusers

Circular ceiling diffusers shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

d) Linear Slot Diffusers

Linear diffuser shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.
e) **Laminar Supply Air Diffusers**

Laminar supply air diffusers shall be made of 2 mm thick powder coated aluminum sheet duly insulated with 5 mm thick closed cell polyethylene foam insulation having factory laminated aluminium foil and joints covered with self adhesive aluminium taps and having holes 2/3 mm dia including frame work.

f) **Volume Control Device**

All supply air outlets shall be fitted with a volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied spaces without removing any access panel. The volume control device for circular outlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/wall outlets and intakes.

vii. **Fresh Air Intake Louvers With Bird Screen**

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminum construction. A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door / wall on which it is mounted. Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/vibrating of the louvers, at not more than 750mm centres where the louver’s length in longer than 750mm.

The intake louvers shall be provided with factory fitted volume control dampers in black finish.

viii. **Painting**

All ducts collar / shoot behind the grills / diffuser shall be given at least two coats oil black enamel paints.

ix. **Testing**

The complete duct system shall be tested for air leakage & complete air distribution system shall be balanced in accordance with air quantities indicated on the approved drawing.

x. **Factory Fabricated Ducting**

1. **General**

Ducting work shall mean all ducts, casing, dampers, access doors, joints, stiffeners and hangers.

2. **Governing Standards**


3. **Duct Materials**

The duct shall be fabricated from Lock Forming Quality (LFQ) grade galvanized steel sheets with 120 gms / sq.m galvanizing (total coating on both sides) on the sheets.

All ducts wherever specified, shall be factory fabricated in box sections from G.I. continuous coils with all suitable joints, supports, sealing arrangements etc.
The thickness of galvanized sheet and type of flange class at 1200 mm spacing shall be as follows:-

<table>
<thead>
<tr>
<th>Size of Duct</th>
<th>Sheet Thickness</th>
<th>Type of Flange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 450 mm</td>
<td>0.50 mm</td>
<td>C&amp;S cleats</td>
</tr>
<tr>
<td>450 mm to 750 mm</td>
<td>0.50 mm</td>
<td>Type E</td>
</tr>
<tr>
<td>751 mm to 1000 mm</td>
<td>0.63 mm</td>
<td>Type E</td>
</tr>
<tr>
<td>1001 mm to 1500 mm</td>
<td>0.63 mm</td>
<td>Type H</td>
</tr>
<tr>
<td>1501 mm to 1800 mm</td>
<td>0.80 mm</td>
<td>Type H</td>
</tr>
<tr>
<td>1801 mm to 2100 mm</td>
<td>1.00 mm</td>
<td>Type J</td>
</tr>
<tr>
<td>2101 mm and above</td>
<td>1.00 mm</td>
<td>Type J</td>
</tr>
</tbody>
</table>

The gauges, joints and bracings for sheet metal ducting work shall further conform to the provision as shown on the drawings.

Ducts larger than 600 mm shall be cross broken or straight beaded. Duct sections upto 1200 mm length may be used with bracing angles omitted.

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the engineer – In – Charge.

All ducts shall be supported from the ceiling / slab by means of fully threaded GI rods of 8 mm – 12 mm dia, with M.S. slotted double – C channel of 3.0 mm thickness at the bottom. The rods shall be anchored to R.C. slab using metallic expansion fasteners.

4. Installation

During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of engineer – In – Charge.

Great care should be taken to ensure that the ducting work does not extend outside and beyond height limits as noted on the drawings.

All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

The ducts shall be reinforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise of vibration.

The ducting work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the engineer – In – Charge. The contractor shall verify all measurements at site and shall notify the engineer – In – Charge. The contractor shall verify all measurements at site and shall notify the engineer – In – Charge of any difficulty in carrying out his work before fabrication.

Self adhesive sponge rubber / PVC gaskets of 6 mm maximum thickness shall be installed between duct flanges as well as between all connection of sheet metal ducts to walls, floor column, heater casing and filter casings. Sheet metal connections shall be made to walls and floor by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
Flanges, bracing and supports shall be galvanized steel. The connection shall be 4 bolts slip on type flange system with sealant injected within the flanges. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

Joints, seams, sleeves, splitter, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineers –in–Charge.

Hexagon nuts and bolts, stove bolts or buck bolts, rivets, or closed center top rivets, or spot welding may fix joints requiring bolting or riveting. Self tapping screws must not be used. All jointing materials must have a finish such as cadmium plating or galvanized as appropriate.

Fire retarding non-porous, vermin proof flexible joints is to be fitted to the suction and delivery of fans. The material is to be normally double heavy canvas or as directed by Engineer-in-Charge. On all circular spigots the flexible materials are to be screws or clip band with adjacent screws or toggle fitting. For rectangular ducts the material is to flanged and bolted with a backing flat or bolted to mating flange with backing flat.

The flexible joints are to not less than 75 MM and not more than 250 MM between faces.

The duct work should be carried out in a manner and at such times as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

Duct passing through brick or masonry, wooden frames work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

5. Dampers

Splitter Dampers

At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.

The dampers shall be of an approved type, lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions, and clearly indicating the damper position.

The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25 mm (18) Gauge, reinforced with 25 mm angles 3 mm thick along any unsupported side longer than 250 mm. Angle shall not interfere with the operation of dampers, nor cause any turbulence.

6. Opposed Blade Dampers

Automatic and manual volume opposed blade dampers shall be complete with frames and nylon bush as per drawings. Dampers and frames shall be constructed of 1.6 mm steel sheets and blades shall be of extruded aluminum of aerofoil design. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with the mesh.

Wherever required for system balancing, a balancing opposed blade damper with quadrant and thumb screw lock shall be provided.

After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.
7. **Access panel**

A hinged and gasketed double skin, factory fabricated access panel measuring at least 450 mm x 450 mm shall be provided on duct work before each fire damper and at each control device that may be located inside the duct work.

8. **Miscellaneous**

All duct work joints are to be true right angle and with all sharp edges removed.

Sponge rubber gaskets also to be provided behind the flange of all grilles.

Each chute from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.

Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by engineer – In – Charge.

The ducts should be routed directly with a minimum of directional change.

All edges shall be machine treated using lock formers, flanges and rollers.

All the flanges shall be connected to the GSS ducts by rivers at 100 mm centres.

The ducts should be supported by approved type supports at a distance not exceeding 2.0 meters

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**ii) Fire Dampers**

i. **Scope of Work**

The scope of this section comprises the supply, installation, testing & commissioning of fire dampers conforming to these specifications and in accordance with Schedule of Quantities.

ii. **Motorized Combined Smoke & Fire Dampers - Spring Return Type**

a) All supply air Ducts in AHU room crossing shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI, Roorkee as per UL555:1973.

b) The fire damper blades & outer frame shall be formed of 1.6 mm galvanized steel sheet. The damper blade shall be pivoted on both ends using chrome-plated spindles in self-lubricating bushes. Stop seals shall be provided on top & bottom of the damper housing made of 16G Galvanized steel sheet. For preventing smoke leakage side seals will be provided.

In normal operating conditions damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

c) The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU Room / R. A. Duct. The fire damper shall close due to temperature rise in S. A. Ducts through the electric temperature sensor, which is factory set at 165 °F.
d) Each motorized smoke cum fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or emergency power supply to show status of the damper (open or close), to allow remote testing of damper, indication in event of damper closure due to signal from smoke sensor / temp. sensor & reset button. Additional terminal will be provided to have audio cum video signal in Central Control Room.

e) Damper actuator shall be such that it should close the damper in the event of power failure automatically and open in the same in case of Power being restored.

f) The fire Damper shall be mounted in fire rated wall with a duct sleeve 600 MM long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI Sheet shall be 18G.

g) The damper shall be installed in accordance with the installation method recommended by the manufacturer.

h) Hinged access doors of suitable size complete with airtight gaskets shall be provided in all fire dampers & plenums.

iii) Insulation / Lining Work

i. Scope of Works

The scope of this section comprises supply & fixing of thermal / acoustic insulation of ducts, pipes etc. as per the specification given below & in accordance with Schedule of Quantities. Insulation shall be Propose CFC and HCFC free insulation

ii. Material & Process of Acoustic Insulation of Duct / AHU Room

a) Resin Bonded Fibre Glass Wool

The Thermal conductivity values in W/m.K of fibre glass shall confirm to following:

<table>
<thead>
<tr>
<th>Mean Temperature</th>
<th>Density In Kg / Cmt.</th>
<th>Thermal Conductivity W/m.k</th>
</tr>
</thead>
<tbody>
<tr>
<td>25PC°C</td>
<td>32/48</td>
<td>0.030</td>
</tr>
</tbody>
</table>

Acoustic Lining of Duct

The material to be used for duct lining shall be 12 / 25 mm thick resin bonded fibre glass rigid board having a density of 48 Kg/m³ & covered with 0.5 mm thick perforated aluminum sheet. The lining of initial length of the duct shall be done as shown in the tender layout drawings & shall be carried out as follows.

a) Clean the duct piece thoroughly,

b) Fix the board of suitable thickness inside the duct & cover with fibre glass tissue paper.

c) Cover the insulation board with 0.5mm thick perforated aluminum sheet with at least 20% perforation.

d) Secure the insulation board & aluminum sheet with cadmium coated bolts nuts & cup washers / steel screws.

f) Finally seal the ends completely, so that no lining material is exposed.
Acoustic Lining of AHU Room

The four walls and ceiling of AHU Rooms shall be provided with acoustic lining of thermal insulation as per following specifications & as specified in the Schedule of Quantities.

a) Clean the surface.

b) A 610 x 610 mm frame work of 25 x 50 x 50 x 50 x 25 mm ‘U’ shape channel made of 0.6 mm. thick G.S.S. shall be fixed on to walls by means of rawl plug in walls & dash fasteners in ceiling. Before fixing channel shall be filled with fibre glass.

c) Fix the resin bonded glass wool having density of 32 Kg/cm² in the frame.

d) Finally, finish it by covering the surface with 0.5 mm thick perforated aluminium sheet with brass screws. Before fixing aluminium sheet, fibre glass tissue paper must be sandwiched.

e) All horizontal and vertical joints shall be covered with at least 25 mm. wide, 1mm aluminium strips held in position by steel or brass screws.

iii. Material & Process of Thermal Insulation of CHW / HW Pipes / AC Equipments

Material

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
- Density of Material shall be between 50+/−10% Kg/m³
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/mK at an average temperature of 0°C.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or ‘μ’ value should be minimum 7000.
- Complete pipe insulation shall have 200 g/m² factory laminated, treated woven Glass Cloth coating for mechanical and UV protection.

Thickness of the insulation shall be as specified for the individual application.

Pipe Insulation

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 25 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:

- Insulating material in tube form shall be sleeved on the pipes.
- On existing piping, pre slit, self adhesive tube with factory laminated woven glass cloth coating shall be placed. Remove the release paper and make a seam joint. Cover the joint with integral glass cloth flap. Butt joints shall be sealed with adhesive and shall be covered with same glass cloth (slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and) adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
- Wherever flat sheets shall be used, Factory cut sheets shall be used (it shall be cut out in correct dimension.) All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
• The insulation shall be continuous over the entire run of piping, fittings and valves.
• All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

The detailed application specifications are as mentioned separately. The manufacturer’s trained installer should only be used for installation.

Recommended Adhesive

In all cases, the manufacturer’s recommended Adhesive (SR-998) should be used for the specified purpose.

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.

Shell Insulation

The chiller shells shall be factory insulated in accordance with the manufacturer’s standards.

Cold Water & Expansion Tank Insulation

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer’s standard.

Parameters for Selection of Thickness

a) Design Basis: Condensation Control
b) Region: Costal Area
c) Application: Outdoor & Indoor
d) Design Conditions: 30 Deg. C & 82 % RH

Thickness of Insulation

a) Chilled Water Pipe Line Temperature 7.0 Deg. C

Indoor Application (Conditioned / Semi Conditioned Space)

- Up To 50 mm Pipe Size - 25 mm Thick Insulation
- Above 50 mm & Up To 150 mm Pipe Size - 32 mm Thick Insulation
- Above 150 mm Pipe Size - 38 mm Thick Insulation
- Chilled Water Tank - 32 mm Thick Insulation

Outdoor Application / Non Conditioned Space

- Up To 50 mm Pipe Size - 32 mm Thick Insulation
- Above 50 mm & Up To 150 mm Pipe Size - 38 mm Thick Insulation
- Above 150 mm & Up To 600 mm Pipe Size - 44 mm Thick Insulation
- Chilled Water Tank - 44 mm Thick Insulation

b) Drain Water Pipe Line Temperature 15.0 Deg. C
Up To 50 mm Pipe Size - 19 mm Thick Insulation

Up To 50 mm Pipe Size - 25 mm Thick Insulation
Above 50 mm & Up To 100 mm Pipe Size - 32 mm Thick Insulation

c) Refrigerant Pipe Line Temperature 3.0 Deg. C

iv. Material & Process of Thermal Insulation of Ducts

Duct insulation: Chemically Cross Linked Closed Cell Polyethylene FR-XPE Fire Retardant grade in roll form density not less than 33±3kg/cum and thermal conductivity 0.0319w/mk at mean temperature of 0ºC. Supply and Return air ducts shall be insulated as shown in the drawing/as specified in the bill of quantities

CASE-1 Supply Air (SA) Duct. (When Return Air is being taken through the False-Ceiling)
Supply Air - 6 mm thick

CASE-2 Supply Air (SA) & Return Air (RA) Duct (When both are in the Non-Conditioned area)
Supply Air – 12 mm thick
Return Air – 6 mm thick

CASE-3 Supply Air (SA) & Return Air (RA) Duct (When both the Ducts are above False Ceiling of Air-conditioned Area)
Supply Air – 10 mm thick
Return Air – 6 mm thick

Insulation for duct shall be applied as follows:

UNEXPOSED DUCT

NORMAL TYPE: (For zones over false-ceiling with plain sheet)

a) Clean the duct surface to be insulated and apply a thin film of adhesive (Pidilite SR 998) and leave it for 2-3 min. for drying. Once the adhesive is dry but tacky to touch, place the insulation sheet in designed position.
b) Press the sheets in position and butt the joints well together.
c) Apply 50mm wide self adhesive tape on both longitudinal and transverse joints.

v. Under deck Insulation with Closed Cell Polyethylene FR-XPE

Ceiling of exposed roof shall be provided with under deck insulation as per following specifications & as specified in the Schedule of Quantities.

a) Clean the surface & apply the adhesive on it.
b) Fix Closed Cell Polyethylene FR-XPE with Overlap Edge of density 33±3kg/cum with the help of adhesive.
c) Apply adhesive between all longitudinal and transverse joints of insulation material.
d) Fix the insulation material finally with the help of rawl plug & dash fasteners in ceiling.

iv) Piping Work

i. Scope of Works
The scope of this section comprises supply, installation, testing & commissioning of chilled water / condenser water / drain water pipes, pipe fittings and valves etc. as detailed below in specifications. All pipes, fittings and valves etc. shall conform to relevant Indian standards.

ii. **Water Piping**

The pipes, fittings and valves shall be of approved make given in the tender & shall be designed for 16 Kg/cm² test pressures.

Chilled / Condenser / Hot water pipes shall be "Heavy" Class “C” M.S. Black pipes up to 150 mm and MS ERW Black Pipes above 150 mm and it shall conform to IS:1239 (Part 1) -1991 & IS:3589 – 1991 Grade 330 with latest amendments. The wall thickness of "Heavy" Class M.S. Black pipes & MS ERW Black Pipes shall be as follows:-

<table>
<thead>
<tr>
<th>Nominal Pipe Dia in mm</th>
<th>Wall Thickness of Pipe in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 25</td>
<td>4.00</td>
</tr>
<tr>
<td>b) 32</td>
<td>4.00</td>
</tr>
<tr>
<td>c) 40</td>
<td>4.00</td>
</tr>
<tr>
<td>d) 50</td>
<td>4.50</td>
</tr>
<tr>
<td>e) 65</td>
<td>4.50</td>
</tr>
<tr>
<td>f) 80</td>
<td>4.80</td>
</tr>
<tr>
<td>g) 100</td>
<td>5.40</td>
</tr>
<tr>
<td>h) 125</td>
<td>5.40</td>
</tr>
<tr>
<td>i) 150</td>
<td>5.40</td>
</tr>
<tr>
<td>j) 200</td>
<td>6.00</td>
</tr>
<tr>
<td>k) 250</td>
<td>6.00</td>
</tr>
<tr>
<td>l) 300</td>
<td>6.00</td>
</tr>
<tr>
<td>m) 350</td>
<td>6.00</td>
</tr>
<tr>
<td>n) 400</td>
<td>6.00</td>
</tr>
<tr>
<td>o) 450</td>
<td>6.00</td>
</tr>
<tr>
<td>p) 500</td>
<td>6.00</td>
</tr>
<tr>
<td>q) 600</td>
<td>8.00</td>
</tr>
<tr>
<td>r) 700</td>
<td>8.00</td>
</tr>
<tr>
<td>s) 900</td>
<td>8.00</td>
</tr>
</tbody>
</table>

Drain water / make up water pipes shall be "B" Class GI Pipe & shall Conform to IS: 4736.

The pipes shall be sized for individual liquid flow & shall ensure smooth noiseless balanced circulation of fluid.

All piping and their steel supports shall be thoroughly cleaned and primer coated before installation.

iii. **Pipe Fittings**

The pipe fittings for screwed piping shall be malleable iron and for piping with welded joints shall of weldable quality. Also the fittings shall be suitable for same pressure ratings as for the piping system.

All bends up to sizes 150 mm dia shall be ready made of heavy duty wrought steel of appropriate class.

All bends in sizes 200 mm and above shall be fabricated from the same dia and thickness of pipe in at least four sections and having a center in radius of at least 1.5 times diameter of pipes. Fittings such as tees, reducers etc. shall be fabricated from the same pipe and its length shall be at least twice the diameter of the pipe.

The dead ends shall be formed with flanged joints & shall have 6mm thick blank between flange pair for 150 mm and over.
iv. **Flanges**

All flanges shall be of mild steel as per IS : 6392 / 71 (with latest amendments) & shall be slip on type welded to the pipes. Flanged thickness shall be to suit Class II pressure. 3 mm thick gasket shall be used in between the flanges.

Flanged pair shall be used on all such equipments which are required to be isolated or removed for service for example condenser / chilled water pumps, chilling m/c, AHU etc.

v. **Piping Installation**

The drawings attached with this tender indicate schematically the sizes, location of pipes & vertical shafts. The contractor, on award of the work, shall prepare detailed shop drawings based on tender drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports.

Piping shall be properly supported on, or suspended from, stands, clamps, springs, hangers as specified and as required at site. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and shall be responsible for their structural sufficiency. A set of piping support calculations shall be submitted for structural engineer review and approval before site installation wherever critical & required.

All pipes in HVAC plant room shall be supported with engineered supports structures made of pipes and channels from floor only with necessary high density PUF pipe supports and engineered vibration / noise isolators.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint 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 Sizes</th>
<th>Spacing Between Supports</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 12 mm</td>
<td>1.2 Meter</td>
<td>8 mm</td>
</tr>
<tr>
<td>15 to 25 mm</td>
<td>1.8 Meter</td>
<td>8 mm</td>
</tr>
<tr>
<td>32 to 150 mm</td>
<td>2.4 Meter</td>
<td>12 mm</td>
</tr>
<tr>
<td>Above 150 mm</td>
<td>3.0 Meter</td>
<td>As Per Approved Drg.</td>
</tr>
</tbody>
</table>

Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on all floors. 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.

T heading in water piping shall be avoided.

Pipe sleeves at least 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 fibre glass and finished with retainer rings welded on the ends of the sleeve. All pipes passing through the retaining wall shall be provided with suitable water proofing compound.

Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant.

Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gauge metal sheets shall be provided between the insulation and the clamp, saddle or roller, extending at least 15 cm on both sides of the clamp, saddles or roller.
All piping work shall be carried out in a workmen like manner & shall be coordinated with other services running in the building. The entire piping work shall be organized, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.

The AC 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.

All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges beveled 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.

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.

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.

vi. Butterfly Valves

Butterfly valves shall be of PN 16 rating as per IS 13095 preferably with fixed linear design to suit duty and flanges as per IS 6392 Table "E". Valves of sizes 32 mm and above diameter shall be made of cast iron close end body, cast iron epoxy coated disc, Nitrile Seat and SS 410 Stem with tefllon bush. Valves up to 150mm NB shall be with detachable hand lever operation whereas valves above 150 mm NB shall have warm gear operation.

These valves shall be installed in condenser / chilled water lines, make up / drain water piping lines. All valves shall be supplied with factory test reports and the manufacturer must have test facilities at their works.

vii. Non-Return Valve (Duct Plate Check Valves)

The dual plate check valves shall be used for horizontal / vertical run of pipes & shall conform to PN 16 rating .The valve design shall confirm to API 594 and tested as per ANSI SERIES.

The valves shall have cast iron body, and SS 410 plates, SS 410 Shaft & Nitrile Seat. All valves shall be supplied with factory test reports and the manufacturer must have test facilities at their works.

viii. Y-Strainer & Pot Strainer

The Y-strainer shall be fabricated out of MS `Heavy` class pipe two size higher than that of strainer pipe size. Flanges as per BS 10 shall be provided at inlet & outlet of connections. The body shall be pressure tested at 16 Kg/Sq. cm and 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 nonmagnetic 20 gauge SS sheet with 3 mm perforation. Strainer shall be provided at inlet of each AHU & chilled water pumps,

Pot Strainer body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chambered 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 gauge 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. Gauge 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 lope 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.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as under.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Pot Dia (mm)</th>
<th>Pot HT (mm)</th>
<th>Element Dia. (mm)</th>
<th>Element HT (mm)</th>
<th>MS Plate (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>300</td>
<td>400</td>
<td>200</td>
<td>240</td>
<td>6</td>
</tr>
<tr>
<td>80</td>
<td>350</td>
<td>450</td>
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<td>250</td>
<td>6</td>
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<tr>
<td>100</td>
<td>450</td>
<td>500</td>
<td>300</td>
<td>280</td>
<td>6</td>
</tr>
<tr>
<td>125</td>
<td>500</td>
<td>600</td>
<td>330</td>
<td>340</td>
<td>8</td>
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<tr>
<td>150</td>
<td>540</td>
<td>700</td>
<td>360</td>
<td>390</td>
<td>8</td>
</tr>
<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>
<tr>
<td>300</td>
<td>1000</td>
<td>1105</td>
<td>750</td>
<td>580</td>
<td>8</td>
</tr>
<tr>
<td>350</td>
<td>1190</td>
<td>1300</td>
<td>895</td>
<td>678</td>
<td>12</td>
</tr>
<tr>
<td>400</td>
<td>1350</td>
<td>1500</td>
<td>1020</td>
<td>785</td>
<td>12</td>
</tr>
<tr>
<td>450</td>
<td>1518</td>
<td>1700</td>
<td>1060</td>
<td>890</td>
<td>12</td>
</tr>
<tr>
<td>500</td>
<td>1690</td>
<td>1800</td>
<td>1100</td>
<td>900</td>
<td>12</td>
</tr>
<tr>
<td>600</td>
<td>2000</td>
<td>2200</td>
<td>1500</td>
<td>1160</td>
<td>12</td>
</tr>
<tr>
<td>700</td>
<td>2200</td>
<td>2400</td>
<td>1600</td>
<td>1300</td>
<td>12</td>
</tr>
</tbody>
</table>

The Y-Strainer & Pot Strainer confirming to SSPL 107 & SSPL 106 shall have cast iron body and factory tested at works at 16 Kg/sq. cm pressure. The screen shall be made out of 3 mm perforated stainless steel sheet. It should be easily removable when required to be cleaned. Isolating butterfly valves at either end of the pot strainer shall be provided.

ix. Balancing Valves

The balancing control and shut off valves with built in pressure drop measuring facility shall be provided in return water lines for air-handling units, chillers, condensers as given in the tender drawings.

The valves of sizes 32 mm to 65mm dia. shall be of gun metal / cast iron construction with screwed ends angular design digital hand wheel with locking facility. Whereas valves of sizes 75mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends. The test cocks should be long enough to protrude out of valve insulation.

The valves shall be designed for PN 1.6 and tested for the seat at 1.1 times the design pressure and 1.5 times the design pressure for the shell. All valves shall be supplied with test certificates and the manufacturer must have test facilities at their works.

x. Pressure Independent Dynamic Balancing Cum Control Valve

These Valves shall be electronic, dynamic, modulating, 2-way, control devices and provided for all AHU cooling coils. Dynamic control valve shall accurately control flow, independent of system pressure fluctuation. These combination valves shall be guaranteed with free replacement for 3 years for any manufacturing or operational defect/mal-operation. Maximum flow setting shall be adjustable to different settings within the range of the valve size. Supplier shall be ISO:9001 and having at least 5 years of successful job experience to supply pressure independent dynamic control valve for similar application of project.
Valve actuator housing shall be rated to IP 40. Actuator shall be driven by a 24V AC and shall accept 2-10 VDC, 0-10 VDC, 4-20 mA, 3-point floating or pulse width modulation electric signal and shall include resistor to facilitate any of these signals. Actuator shall be capable of providing 4-20 mA or 2-10V DC feedback signal to the control system for Valves installed across AHU. The same is not required for Valves installed across FCUs. External LED readout of current valve position and maximum valve position setting shall be available for the Valves installed across AHU. Manual override to either a fully closed or fully open valve position shall be possible. The valve provided shall have facility of providing flow measurement through the valves.

Housing for 15 – 40 mm size shall be constructed of forged ASTM brass rated at no less than 1600 kPa static pressure minimum and 110°C. Housing for 50 – 150 mm shall be constructed of Ductile Iron ASTM A536-65T, Class 60-45-18 rated at no less than 1600 kPa static pressure minimum and 120°C. Valve housing for 15 – 40 mm shall be double union construction with a range of pipe connections available for the appropriate pipe size. Identification tags shall be available for all valves.

Flow regulation unit shall consist of stainless steel and hydrogenated acrylonitrile butadiene rubber and shall be capable of controlling flow within +/- 5% of each rated flow or Flow regulation unit shall consist of glass reinforced poly-phenylene-sulfide with a hydrogenated acrylo-nitrile butadiene rubber diaphragm. Flow regulation unit shall be accessible, for maintenance. Dual pressure/temperature test plugs for verifying accuracy of flow performance shall be provided for valve sizes 25mm and above.

xi. **Normal Three / Two Way Valve**

The three / two way modulating valves shall be provided in chilled water line to the cooling of Air-handlers which is actuated by a space / duct mounted proportionate thermostat. The three - way valve shall be selected for valve authority value in the range of 30 % to 60 %. These valves shall consist of bronze metal valve body with stainless steel trim with linear flow characteristics. Modulating motor suitable for 24 volts AC supply shall be complete with 220/24 volts transformer & shall be suitable for operation with a signal of 0-10 volt DC from the proportionate thermostat. The valve linkages shall be of the same make as of valves & modulating motor. Constant space condition shall be maintained by continuous proportional modulation of chilled water through the coil. The valve shall revert to fully by pass position when fan is shut off. The pressure drop across valve for air-handler unit shall not exceed 5.0 PSI.

xii. **Air-Vents**

Air vents for purging of air trapped in piping system shall be provided at the highest point. Globe valves of the size as indicated below shall be provided & no additional price shall be paid.

xiii. **Pressure Gauges / Thermometers**

**Pressure Gauges**

Burden type pressure gauges of 100mm dia of suitable range shall be provided at the following locations:

a) Chiller / Condenser / Cooling coils of AHU - Inlets and outlets.
b) All pumps - Suction & discharge

The water pressure gauge shall be made of stainless steel grade SS304. The dial plate shall be powder coated with white colour base & the calibration shall be done in black colour. All the pressure gauges shall be complete with ball valves & SS Siphon and confirming to IS: 3624.

**Thermometer**

Direct reading V form type thermometer alcohol filled of suitable range / length shall be provided at the following locations:

a) Condenser / Chiller / Cooling coil – Inlets and outlets in separate wells of Brass / Gun metal.
The V form thermometer shall be made of aluminium die casting with golden colour anodizing. The thermometer shall have a V groove in the body to protect the refill from the damages during the installation. The refill shall be filled with blue colour mercury. The thermometer shall be complete with brass well & the calibration of temperature shall be in Celsius & Fahrenheit

xiv. Testing Of Pipe System

During construction the AC 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.

All piping shall be tested to hydrostatic test pressure of at least one and half times the maximum operating pressure, but not less than 16 kg per sq. cm gauge for a period of not less than 24 hours. All leaks and defects in joints found during the testing shall be rectified, retested and gotten approved.

Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

Piping may be tested in sections and such sections shall be securely capped, then retested for the entire system.

The AC Contractor 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.

The AC Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils. 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.

After the piping has been installed, tested and run for at least 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.

The AC Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test.

xv. Balancing

After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified or required.

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.

Complete certified balancing report should be submitted for evaluation by the consultant or his authorized representatives. Upon endorsement three copies of the balancing report shall be submitted with the as-built drawings and completion documents.

v) Insulated Flexible ductwork

Insulated Flexible ductwork shall be as described in the SMACNA Low Pressure Duct Standards (5th Edition).
a. Where flexible connections are indicated or required between rigid ductwork and particular components or items of equipment, the internal diameter of the flexible duct shall be equal to the external diameter of the rigid ductwork and of the spigot served. The use of flexible duct between rigid sections of sheet metal ductwork to change direction or planes will not be permitted except where indicated or expressly authorized by the Owner.

b. The flexible duct shall have a liner and a cover of tough tear-resistant fabric equal in durability and flexibility to glass fibre and shall be impregnated and coated with plastics. It shall be reinforced with a bonded galvanised spring steel wire helix between the liner and the cover and an outer helix of glass fibre cord or equal shall be bonded to the cover to ensure regular convolutions.

c. Alternatively the flexible duct shall consist of flexible corrugated metal tubing of stainless steel, aluminium, tinplated steel or aluminium coated steel. The metal may be lined on the inside or the outside or both with plastics material.

d. The joints of rigid spigots shall be sealed with a brush coat of pipe jointing paste or mastic compound. Ducts up to 150mm diameter shall be secured with a worm drive type hose slip. Ducts over 150mm diameter shall be secured with a band clip.

e. The frictional resistance to air flow per unit length of the flexible duct shall not exceed 50% more than the frictional resistance per unit length of galvanised steel ducts of equivalent diameter. The radius ratio R/D for bends shall not be less than 2, where R is the centre line radius and D is the diameter of the flexible duct.

f. Flexible ductwork shall not pass through fire/smoke resistant building construction nor be used at extract points where deposits of flammable substances are likely to occur in high fire risk areas.

g. The leakage from any section of flexible duct shall not exceed 1% of the design air flow rate at the static operating pressure.

h. Flexible ducts shall be suitable for an operating temperature range of -18°C to 120°C and shall comply with BS 476 Part 1, Section 2, Clause 7 (Class 1: Surface of very low flame spread).

E) **NOISE & VIBRATION CONTROL**

i) **Scope of Work**

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

ii) **Standards**

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

- **BS 4718: 1971** Methods of Test of Silencers for Air Distribution Systems
- **BS 2750:** Laboratory and Field Measurement of Airborne Sound
- **Parts 1-9: 1980** Insulation of Various Building Elements
- **Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings**
- **BS 3638: 1987** Methods of Measurement of Sound Adsorption in a Reverberation Room
iii) General

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation:

All moving plant / equipment shall be statically and dynamically balanced at manufacturers works and certificates issued.

The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.

Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant rooms.

The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.

Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.

All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.

Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

iv) Sound Attenuators

Attenuators shall be provided in ducts in accordance with acceptable noise level criteria & if specified in BOQ. Attenuators shall be constructed from high quality pre-galvanized steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with red oxide primer paint. Acoustic splitters shall be formed by chancel section pre-galvanized sheet steel framework retaining acoustic fill of a density to attain the
required performance. Splitters shall have round Nos. ends to give smooth entry and exit conditions to minimize air pressure drops. The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanized sheet steel. All attenuators shall be selected against a maximum allowable air pressure drop of 100 Pa.

It will be the responsibility of the AC Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

v) Anti-vibration Mountings.

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels.

Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections.

Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suite the application. Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti-vibration mountings and concrete filled steel upper plinth. The AC Contractor shall be responsible for providing the steel upper plinth and mountings.

Pipe work connections to circulating pumps, chillers, cooler coils and other heat exchanger equipment shall be made with flexible connections as per piping Specifications.

The construction of the anti-vibration mountings shall generally comply with the following:

Enclosed Spring Mounting (Caged or Restrained Springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built-in leveling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Mountings incorporating snobbery of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

The manufacturers shall provide restrained isolator on chillers subject to approval.

vi) Open Spring Mountings

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.
vii) Neoprene-in-Shear Mountings

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a leveling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

viii) Inertia Bases For Pumps.

The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 1/12 of the longest span between isolator but not less than 150 mm. filled with concrete the density of which shall be 2300 kg/m³.

The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any component, which overhands the equipment base, such as suction, and discharge elbows on centrifugal pumps.

The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolt location adjustment.

Isolator support brackets shall be welded into the corners of the base and suitably re-enforced for the load of the equipment and base.

Additional reinforcing roads shall be provided at 200 mm. centres to ensure the concrete and frame is adequately stiffened against distortion.

F) QUALITY ASSURANCE

i) General

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), Manufacturing quality assurance program (MQAP), field quality assurance program (FQAP) and quality plan.

II. Tests at manufacturer’s works.

III. Perform site tests and commissioning.

ii) Submittals

I. After award of work following information shall be submitted.

   a. Quality Assurance Program (QAP)
   b. Manufacturing Quality Assurance program (MQAP)
   c. Field Quality Assurance Program (FQAP)

II. For inspection and testing, submit inspection and testing procedures, program, and record sheets applicable at each hold point.

III. After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
IV. For site installation and commissioning, submit installation methods or procedures, notification and procedures for pre-commission and commissioning.

V. After commissioning, submit site test records, as-built drawings, manufacturer’s operation maintenance manuals and list of recommended spares and tools.

### iii) Quality Assurance Concept and Control

I. Minimum requirements for establishing and implementing a quality assurance program 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 AC Contractor’s quality assurance program does not relieve the Contractor’s obligation to comply with the requirement of the contract document. If the program is found to be ineffective, then the Consultant / Client or his authorised representatives reserves the right to request for necessary revisions of the program.

III. The AC Contractor is required to produce readily identifiable documentary evidence covering the extent and details of both his own and his Subcontractor’s quality assurances system as follows:

- Quality Assurance Program (QAP)
- Manufacturing Quality Assurance program (MQAP)
- Field Quality Assurance Program (FQAP)
- Quality Plan.

IV. These documents shall be prepared separately and submitted to the Consultant / Client or his authorized representatives at the time of starting the work.

V. Quality Plan and Manual shall be prepared by the AC 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 Consultant / Client or his authorized representatives before start of work.

### iv) Quality Assurance Manual (QAM)

I. The QAM shall be a general comprehensive document outlining the AC Contractor’s basic organization, policies and procedures. The information to be given in the QAM shall include but not limited to:

- Quality Policy.
- Quality Assurance Program
- Organization Structure showing inter relationships.
- Functional responsibilities and levels of authority.
- Lines of communication.
- Customer relations.
- Laboratory Facilities.

### v) Manufacturing Quality Assurance Programme (MQAP)

I. The MQAP shall identify the AC Contractor’s Quality Assurance Program at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the program elements to be designed, developed, executed and maintained by the AC Contractor for the purpose of ensuring that all supplies and services comply with these specifications.

II. The information to be given under this program shall include but not limited to:
b. Contract Review.
c. Design and Document Control.
d. Procurement Control.
e. Production Control.
f. Control on Subcontractors.
g. In-process Quality Control and Traceability.
h. Inspection and Testing.
j. Control of Non-conformances.
k. Corrective Action.
l. Control of Inspection, Measuring and Test Equipment.
m. Handling, Storage, Packaging and Delivery.
n. Records.
o. Quality Audits.
p. After - Sales Servicing.

vi) Field Quality Assurance Programme (FQAP)

I. This programme shall identify the AC Contractor’s Quality Assurance Program 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 MQAP, 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.
i. Pre-commissioning.
j. Commissioning.
k. Control of Non-conformances.
m. Corrective Action.
n. Control of Inspection, Measuring and Test Equipment.
o. Records.
p. Completion Documents.
q. List of recommended spares and tools.
r. Personal Training.
s. Servicing during DEFECTS RECTIFICATION PERIOD.

vii) Quality Plan

I. The AC 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 Consultant / Client or his authorized representatives in the inspection and test programs.

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.

viii) Site Quality Control Section

I. The AC 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 AC Contractor’s Site Manager only on administrative matters, but otherwise under full control by the AC Contractor’s Corporate Quality System Management.

II. The AC Contractor’s Q.C. Section shall liaise closely with the Consultant’s or his authorized representatives 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 AC Contractor’s Q.C. Engineer implements the Consultant’s Quality Program, the adequacy and effectiveness of that implementation shall be audited by the Consultant / Client or his authorized representatives whose recommendations on improving or maintaining quality shall be acted upon promptly by the AC Contractor’s Q.C. Section.

ix) Inspection and Testing

I. All equipment and components supplied may be subjected to inspection and tests by the Consultant / Client or his authorized representatives during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this contract document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.

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 Consultant / Client or his authorised representatives.

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 Consultant / Client or his authorised representatives may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the Consultant / Client or his authorised representatives, the Consultant shall submit the item for further inspection and/or test.

V. The acceptance of the Consultant / Client or his authorised representatives of inspection and/or test results shall not prejudice the right of the Consultant or his authorised representatives to reject an item of equipment if it does not comply with the contract document when erected, does not or proves completely satisfactory in service.

VI. The Consultant / client’s representative shall be responsible for the timely transmission of the relevant and appropriate sections of the contract document to manufacturers and AC Contractors for the proper execution of all tests at their works as per contract specifications.

x) Tests at Manufacturer’s Works

I. All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Consultant or his authorized representatives prior to commencement of the work. The AC Contractor shall prepare the details of the schedule and submit these to the Consultant / Client
or his authorised representatives for endorsement. 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 made available to the Consultant / Client or his authorised representatives who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections. AC Contractor shall arrange inspection and factory witness test for chiller.

II. A minimum of fifteen days’ notice of the readiness of equipment for test or inspection shall be provided to the Consultant / Client or his authorised representatives by the AC Contractor (whether the tests be held at the Subcontractor of AC Contractor’s works). The subject items should remain available for Consultant / Client or his authorised representatives inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the Subcontractor and AC Contractor to enable the Consultant / Client or his authorized representatives 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 Consultant / Client or his authorised representatives 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 Consultant / Client or his authorised representatives in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed program of tests to be agreed.

V. The Consultant / Client or his authorised representatives reserves the right to visit the Manufacturer’s works at any reasonable time during fabrication of equipment and to familiarize himself 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 Consultant / Client or his authorised representatives.

VII. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Consultant / Client or his authorized representatives 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 AC Contractor into volumes and bound in an approved form complete with index and four copies of each volume shall be supplied to Consultant / Client or his authorized representatives.

IX. Stage wise inspection of equipment in factory in waived.

x) Performance Tests at Manufacturer’s Works

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% over speed 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 AC 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 endorsement of the Consultant / Client or his Authorised representatives.

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 endorsement of the Consultant / Client or his authorised representatives.

V. On completion of the tests the AC Contractor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

G) TESTING, ADJUSTING AND BALANCING

The AC Contractor shall have a dedicated experienced, specialized, approved, testing and commissioning (T&C) team /agency responsible for coordination with other trades, preparation of T&C plan method statement & T&C procedures, organizing & scheduling the T&C activities along with the progress of works, supervision any re-testing, coordination with third parties for commissioning & certification, organizing & performing testing for satisfaction of all Statutory Bodies, T&C record documentation & handover

i) General

a. Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.

b. Testing, adjusting and balancing of HVAC Hydronic 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 Assoc.ciations including:


SMACNA : Manual for the Balancing and Adjustment of air distribution system.

d. AC Contractor shall submit a Test, adjust, balance procedure/method statements/charts for approval to Client.

ii) 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.

e. Adjust and balance to design parameters.
f. Record and report results as per the formats specified.

iii) 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.

iv) 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 AC Contractor shall intimate the Client about his readiness to conduct the TAB procedures in the format given in these specifications.

v) 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.

d. All cooling tower (condenser) water systems.

e. Emergency purge systems.

vi) Air Systems

I. 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.

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.

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 is of proper construction and is equipped with turning vanes and joints are sealed.
h. Test holes and plugs for ducting.

vii) 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-ordinated drawings and approved submittals and system sketch with design water flows specified thereon.
• Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.
• Hydronic system is vented.

III. The AC 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 preset 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 Client / Consultant for endorsement.

viii) Readiness for Commencement of Tab

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

ix) Tab Instruments
I. Air Measuring Instruments
   a. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA. 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. 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 need. 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, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the PMC.

    Sound level readings shall be taken at ten (10) locations in the building as selected by the Contractor / Client. The readings shall be taken on an Octave Band analyzer in a manner acceptable to him. The AC 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 test shall be performed in the presence of Client / Consultant or his authorized representative.
<table>
<thead>
<tr>
<th>Description</th>
<th>Ready</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. HVAC Units (AHU)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) General</td>
<td></td>
<td></td>
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<tr>
<td>Louvers installed</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Manual dampers open &amp; locked</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Automatic dampers set properly</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Housing Construction leakage</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Access doors-leakage</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Condensate drain piping and pan</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Free from dirt and debris</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Nameplate data</td>
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<tr>
<td>b) Filters</td>
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<td></td>
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<tr>
<td>Type and size</td>
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<td>Number</td>
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<td>Clean</td>
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<td>Frame-Leakage</td>
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<td>c) Coils (Hydronic)</td>
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<td>Size and rows</td>
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<td>Fin spacing and condition</td>
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<td>Obstructions and / or debris</td>
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<td>Airflow and direction</td>
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<td>Piping leakage</td>
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<td>Correct piping Connections and flow</td>
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<td>Valves open or set</td>
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<td>Air vents or steam traps</td>
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<td>Provision made of TAB Measurements</td>
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<td>d) Fans</td>
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<td>Rotation</td>
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<tr>
<td>Wheel clearance and balance</td>
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<td></td>
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<td>Bearing and motor lubrication</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Drive alignment</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Belt tension</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Drive set screws tight</td>
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<td>Belt guard in place</td>
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<tr>
<td>Flexible duct connector alignment</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Starters and disconnect switches</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Electrical service &amp; connections.</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Nameplate data</td>
<td>Yes</td>
<td></td>
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<tr>
<td>e) Vibration Isolation</td>
<td></td>
<td></td>
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<tr>
<td>Springs &amp; Compression</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Base Level &amp; Free</td>
<td>Yes</td>
<td></td>
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<tr>
<td><strong>2. Duct System</strong></td>
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<td></td>
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<tr>
<td>a) General</td>
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<td></td>
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<tr>
<td>Manual dampers open &amp; locked</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Access doors closed and tight</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Fire dampers open and accessible</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Terminal units open and set</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Registers and diffusers open and set</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Turning vanes in square elbows</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Provisions made for TAB measurements.</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Systems installed as per plans.</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
Ductwork sealed as required

b) Architectural
   Windows installed and closed.
   Doors closed as required.
   Ceiling plenums installed and sealed.
   Access doors closed and tight
   Air shafts and openings as required

3. Pumps
   a) Motors.
      Rotation
      Lubrication
      Alignment
      Set screws tight
      Guards in place
      Tank level and controls.
      Starters and disconnect switches
      Electrical service & connections.
      Nameplate data.
   b) Piping
      Correct flow
      Correct connections
      Leakage
      Valves open or set
      Strainer clean
      Air vented
      Flexible connectors
      Provisions made for TAB measurements
   c) Bases
      Vibration isolation.
      Grouting
      Leveling

4. Hydronic Equipment
   a) Heat Exchangers/HW coil
      Correct flow and connections
      Valves open or set
      Air vents or steam traps
      Leakage
      Provisions made for TAB measurements
      Nameplate data.
   b) Cooling towers
      Correct flow and connections.
      Valves open or set
      Leakage
      Provisions made for TAB measurements
      Sump water level.
      Spray nozzles.
      Fan/pump rotation.
      Motor/fan lubrication.
      Drives and alignment
      Guards in place.

5. Refrigeration Equipment
   Crankcase heaters energized
6. Hydronic Piping Systems
   - Leak tested.
   - Fluid levels and make-up
   - Relief or safety valves.
   - Compression tanks and air vents.
   - Steam traps and connections.
   - Strainers clean
   - Valves open or set
   - Provisions made for TAB measurements.
   - Systems installed as per plans.

7. Controls System
   - Data centers.
   - Outdoor return air reset
   - Economizer
   - Static pressure
   - Room controls.

8. Other Checks
   a) Other trades or personnel notified of TAB work requirements.
   b) Preliminary data complete
   c) Test report forms prepared.
INSTRUMENT CALIBRATION REPORT

PROJECT ________________________________

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REMARKS

TEST DATE _______________ READINGS BY _______________________

Page 287
CHILLER TEST REPORT

PROJECT___________________________ UNIT_____________________

LOCATION____________________________________________________

MANUF.___________ MODEL ____________ SERIAL NO. _____________

CAPACITY_____ REFRIG_____ STARTER_____ HEATER SIZE_____

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Relief Valve Setting  
IKW / Ton

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Make/Model  
No. of Passes  
Ref : Pressure / Temp  
Ent. Water Temp / Pressure  
Leaving Water Temp/Pressure  
Temperature Difference  
Pressure Difference  
Water Quantity  
Relief Valve Setting

REMARKS

TEST DATE _______________ READINGS BY ______________________
## PUMP TEST REPORT

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### REMARKS

TEST DATE ________________ READINGS BY ______________________
COOLING TOWER TEST REPORT

PROJECT______________________ SYSTEM_____________________

LOCATION____________________________________________________

MANUF._____________ MODEL_____________  SERIAL NO.___________

NOM. CAPACITY ______________________ WATER TREAT.__________

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**REMARKS**

**TEST DATE ____________ READINGS BY _________________________**
## AIR HANDLING EQUIPMENT TEST REPORT

**PROJECT**

**SYSTEM/UNIT**

**LOCATION**

### Description Data

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### REMARKS

**TEST DATE**

**READINGS BY**
## COOLING / HEATING TEST REPORT (AHU)

### PROJECT

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# FAN COIL TEST REPORT

**PROJECT**

**DATE**

**LOCATION**

**MANUFACTURER**

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**REMARKS**

**TEST DATE**

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</tr>
<tr>
<td>FAN RPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.P IN/OUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL S.P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amperage</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Remarks:**

**Test Date:** ____________ **Readings by:** ________________
RECTANGULAR DUCT TRAVERSE REPORT

PROJECT___________________ SYSTEM_______________________

LOCATION / ZONE_______ ACTUAL AIR TEMP. ______ DUCT S.P____

<table>
<thead>
<tr>
<th>DUCT SIZE</th>
<th>REQUIRED SQ.FT.</th>
<th>FPM</th>
<th>CFM</th>
<th>FPM</th>
<th>CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSITION 1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
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<tr>
<td>3</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td></td>
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</tr>
</tbody>
</table>

VELOCITY SUBTOTALS

REMARKS

TEST DATE_________ READINGS BY __________________________
GRILLES AND DIFFUSERS TEST REPORT

PROJECT_____________ SYSTEM ____________________________
OUTLET_____________ MANUFACTURER____________________
TEST APPARATUS________________________________________

<table>
<thead>
<tr>
<th>S/N</th>
<th>AREA SERVED</th>
<th>OUTLET NO./TYPE/SIZE</th>
<th>DESIGN CFM/VEL</th>
<th>PRLIMINARY VEL/CFM</th>
<th>FINAL VEL/CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
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<tr>
<td>4.</td>
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<td>5.</td>
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<td>7.</td>
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<tr>
<td>8.</td>
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<td>9.</td>
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<td>10.</td>
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<td>11.</td>
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<tr>
<td>12.</td>
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<tr>
<td>13.</td>
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<tr>
<td>14.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REMARKS

TEST DATE___________ READINGS BY _________________________

END OF TESTING, ADJUSTING & BALANCING SPECIFICATION
H) **PAINTING WORK**

This section deals with painting of various equipment / material supplied under this contract. It gives basic guidance for painting as specified below:

**Application** : The original colour of all equipments like water chilling machines, air-handling units etc. which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

All chilled water pipes shall be painted as per standard code of practice and arrows shall be marked to indicate direction of flow of water.

### i) Colour Scheme For The Equipments / Materials

<table>
<thead>
<tr>
<th>Description</th>
<th>Standard Colour &amp; Reference</th>
<th>Lettering Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed Duct Work (other than plant room)</td>
<td>To requirement</td>
<td>Contractor instruction</td>
</tr>
<tr>
<td>Air Conditioning Duct Work (Plant Rooms)</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Ventilation Duct Work (Plant Rooms)</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Conditioner Casings, Air Handling Units, Filter Plenums</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Electrical (Conduit Ducts and Motors)</td>
<td>BSS 557 Light Orange</td>
<td>Black</td>
</tr>
<tr>
<td>Chilled Water Pipe</td>
<td>Jade Green</td>
<td>Black</td>
</tr>
<tr>
<td>Drains</td>
<td>Black</td>
<td>White</td>
</tr>
<tr>
<td>Vents</td>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>Fans</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Valves and Pipe Line Fittings</td>
<td>White with black handles</td>
<td>Black</td>
</tr>
<tr>
<td>Beltquards</td>
<td>Black and yellow diagonal stripes (45 25 mm wide)</td>
<td></td>
</tr>
<tr>
<td>Switchboards- exterior – interior</td>
<td>BS 366 Light Beige</td>
<td>White</td>
</tr>
<tr>
<td>Machine Bases, Inertia Bases and Plinths</td>
<td>Charcoal</td>
<td>Grey</td>
</tr>
<tr>
<td>Chilling M/C</td>
<td>As Per Manufacturer’s Standard</td>
<td></td>
</tr>
<tr>
<td>Pump-sets</td>
<td>Battle ship grey</td>
<td></td>
</tr>
<tr>
<td>Condenser water pipes</td>
<td>Light green</td>
<td>Black</td>
</tr>
<tr>
<td>Description</td>
<td>Standard Colour &amp; Reference</td>
<td>Lettering Colouring</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Electrical panels/sub-panel/remote control console</td>
<td>Light grey powder coated RAL 7032 as per DIN</td>
<td></td>
</tr>
<tr>
<td>Supports for ducts</td>
<td>Silver</td>
<td></td>
</tr>
</tbody>
</table>

ii) Structural Supports

No extra price shall be paid on account of structural supports required for piping, ducting & cabling work.

iii) Flexible Pipe Connector

Flexible pipe connector wherever required are part of the equipment & are specified in BOQ with the equipment. No extra price shall be paid on account of this.

I) SYSTEM TESTING, INSPECTION PROCEDURE & PERFORMANCE TEST READINGS

i) Inspection Procedure For Central Air-Conditioning Plant

All major equipments such as Chilling machine, AHU, Electrical Panel, etc. shall be got inspected & tested before dispatch of equipments by the Engineer in Charge at works if he so desires. All type of routine and type tests shall be carried out at the works. The Engineer shall be free to witness any or all tests if he so desires. In case the Engineer in charge or his representative is unable to witness the test at the manufacturer’s works, the contractor shall furnish the manufacturers test certificate to the satisfaction of the Engineer in charge. The AC contractor shall intimate the Engineer in Charge in advance about the date of readiness of equipments for inspection & testing. The inspection procedure for testing of AC equipments are given below:-

ii) Initial Inspection

i. Chilling Machine

Salient features such as model no. of compressor, chiller & condenser, dimension of the machine, microprocessor panel etc shall be verified against the requirement.

Manufacturer’s internal test certificate shall be scrutinized to check compliance with the requirement as per specification.

Salient features of condenser & chiller such as number of tubes, inside diameter of tubes, tube thickness & material, No. of passes, type of fins, length of condenser & chiller etc. shall be verified.

ii. Cooling Coils:

Salient features of cooling coils such as material of tube, tube diameter, tube wall thickness, fin material & no. of fins per inch, gauge of fins & no. of rows shall be furnished and verified with reference to contract requirement.

Manufacturer’s internal test certificate indicating results of pneumatic / hydraulic pressure test shall be scrutinized to check compliance with the requirement as per specification.

iii. Air Handling Units:
Salient features such as model, size, physical dimension & other details of various section, fan motor details, fan dimension etc. shall be verified against the contract requirement.

Manufacturer’s internal test certificate for the motor and air handling units shall be Furnished and scrutinized as per contract requirement.

Test certificate for static and dynamic balancing of the blower should be furnished.

iv. **Pumps**

Salient features such as model and make shall be checked as per contract requirement.

The manufacturer’s test certificate will be furnished and verified against contract Requirement.

v. **Switch, Gear, Control Gear, Measuring Instruments & Power / Control Cables**

They should be of approved make. For air circuit breakers the contractor shall furnish manufacturer’s test certificate and the same shall be verified as per contract requirement.

vi. **Electric Motor**

Electric motor should be of approved make. Test certificate for electric motor shall be furnished & verified as per contract.

vii. **Pipes & Valves:**

Make of pipe & valves shall be verified as per contract.

Wall thickness of pipes shall be verified as per contract.

viii. **Ducting:**

The GS sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness, bend test and galvanizing test as per relevant IS specifications.

ix. **Thermal Acoustic / Insulation:**

Physical verification for thickness and make should be as per contract before application of insulation.

Manufacturer’s test certificate for density & thermal conductivity should be furnished.
iii) Final Inspection

After completion of entire installation, as per specifications in all respects, the AC contractor shall demonstrate trouble free operation of the AC equipment for a period of 30 working days subject to a minimum of 300 hours of running. Any defects found during this operation shall be rectified immediately before the initial test period of 30 days is over.

The initial test, which has to be carried out by the contractor at his own expense & shall be as follows but not limited to:

a) To check satisfactory functioning of all major equipments such as Chilling m/c, electrical motors, pumps, cooling tower, switch gear, air handlers etc.

b) To check alignments of motors.

c) To operate chilling m/c, pump sets, air handlers etc. and adjust water flow in all line i.e. chilled water line and in the cooling coils.

d) To check and balance air distribution system.

NOTE: All test instruments such as thermometer, psychrometer, pressure gauges, anemometer, flowmeter, decibel meter or the contractor at his own expense shall arrange any other necessary instrument.

After initial test the plant shall be run continuously for a period of 10 working days before the guarantee comes into force. In addition to the initial test as explained in this section the contractor shall also give the two continuous running test of the system during peak summer, monsoon & winter for 10 hrs. For 3 days when the ambient are closed to the designed conditions.

In case, the peak ambient conditions in the respective seasons are not found to be close to designed ambient conditions, the test shall be conducted on closest ambient conditions and capacity of equipments shall be computed and compared with capacities indicated in the contract. Water and power for testing and commissioning of the system shall be provided free of cost by the Client.

iv) Capacity of Plant

The test readings shall be recorded & capacity of various of major equipments such as, compressor, condenser, chiller, cooling coil, cooling tower, fan coil units, pump sets etc. shall be worked out as per computation formulas given in this section.


   a) Compressor

      \[
      \text{IKW/\text{Ton}} = \frac{\text{Power input in KW}}{\text{Compressor Cap. in tons}}
      \]

      The contractor shall compare the capacity & IKW/TR of compressor from manufacturers computer selections supplied.

   b) Condenser / Chiller

      \[
      \text{Heat Rejection of Condenser} = \text{Water flow through condenser (Usgpm) x Temp. Difference Deg.F.}^{24}
      \]

   c) Cooling Coils of Air Handlers and Fan Coil Units
Capacity of cooling coil = \( \frac{\text{UCFM} \times 60 (\text{he} – \text{hl})}{\text{Avg specific volume V} \times 12000} \)

Where \( \text{he} \) = Enthalpy of entering air in btu / lb
\( \text{hl} \) = Enthalpy of leaving air in btu / lb
\( V = V_e + V_l \)
\( = \text{Specific volume of air entering CFT /lb of air} + \text{specific volume of leaving air CFT / lb of air.} \)

The interlocking connection of compressor motor with condenser and chilled water pumps cooling tower fan etc. shall be checked.

v) **Performance Test Reading**

The Test Readings shall be recorded on hourly basis during the summer / monsoon seasons after satisfactory commissioning of AC System at site as per the Performa indicated in Testing, Adjusting and Balancing Section of Tender Document.

I. **OUTSIDE DESIGN CONDITIONS**

a) Season :

b) Dry bulb temp. °C :

c) Wet bulb temp. °C :

II. **INSIDE DESIGN CONDITIONS IN EACH AREA.**

a) Dry bulb temp. °C :

b) Wet bulb temp. °C :

c) Relative Humidity % :

III. All electrical panels / cables / starters / single phase preventer etc. shall be tested as per standard code of practice.

J) **IDENTIFICATION OF SERVICES**

i) **General**

This section comprises of identification of services for each piece of equipment

ii) **Valve Labels and Charts**

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and “as fitted” drawings. The labels shall be made from 3 ply (black / white/ black) Traffolyte material showing white letters and figures on a black background. Labels to be tied to each valve with chromium plated linked chain. The labels shall be suitable for minimum 40 characters with font size of 24 minimum. Labeling scheme of each equipment to be submitted for approval from Client / Consultant.

A wall mounted, glass covered plan to the endorsement of the Client / Consultant shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.
All AC equipments shall be provided with permanent mounted identification labels and unique tagging numbers. The shop drawings shall also include these tagging numbers for easy identification on site. It should be co-ordinate with BMS also to ensure consistent equipment tagging among drawings, BMS display and site installation.

iii) Identification of Services

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

i. Pipe Work Services

For pipe work services and its insulation the colours of the bands shall comply with BS.1710: 1971.

Basic colours for pipe line identification:

<table>
<thead>
<tr>
<th>Pipe Line Contents</th>
<th>BS. 4800 Colour Reference</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>12 D 45</td>
<td>Green</td>
</tr>
<tr>
<td>Steam</td>
<td>10 A 03</td>
<td>Grey</td>
</tr>
<tr>
<td>Oils</td>
<td>06 C 39</td>
<td>Brown</td>
</tr>
<tr>
<td>Gas</td>
<td>08 C 35</td>
<td>Yellow / Brown</td>
</tr>
<tr>
<td>Air</td>
<td>20 E 51</td>
<td>Blue</td>
</tr>
<tr>
<td>Drainage</td>
<td>00 E 53</td>
<td>Black</td>
</tr>
<tr>
<td>Electrical</td>
<td>06 E 51</td>
<td>Orange</td>
</tr>
</tbody>
</table>

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

<table>
<thead>
<tr>
<th>Pipe Line Contents</th>
<th>Colour Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>00 E 55</td>
</tr>
<tr>
<td>Fresh / drinking</td>
<td>18 E 53</td>
</tr>
<tr>
<td>Boiler feed</td>
<td>04 D 45/00 E 55 / 04 D 45</td>
</tr>
<tr>
<td>Condensate</td>
<td>04 D 45/14 E 53 / 04 D 45</td>
</tr>
<tr>
<td>Chilled</td>
<td>00 D 55/14 E 53 / 00 D 45</td>
</tr>
<tr>
<td>Central Heating Services :</td>
<td></td>
</tr>
<tr>
<td>Below 100 Deg. C</td>
<td>18 E 55/04 D 45/18 E 53</td>
</tr>
<tr>
<td>Above 100 Deg. C</td>
<td>04 D 45/18 E 53 /04 D 45</td>
</tr>
<tr>
<td>Cold Water Storage</td>
<td></td>
</tr>
<tr>
<td>Tanks:</td>
<td>00 E 55/18 E 53/00 E 55</td>
</tr>
<tr>
<td>Hot Water Supply</td>
<td>00 E 55/04 D 45/00 E 55</td>
</tr>
<tr>
<td>Hydraulic Power</td>
<td>04 C 33</td>
</tr>
<tr>
<td>Sea / River Untreated</td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Fire Extinguishing</td>
<td>04 E 53</td>
</tr>
<tr>
<td>Steam Services :</td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Air : Compressed</td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Vacuum</td>
<td>White</td>
</tr>
<tr>
<td>Town Gas : Manufactured</td>
<td>14 E 53</td>
</tr>
<tr>
<td>Natural</td>
<td>10 E 53</td>
</tr>
<tr>
<td>Pipe Line Contents</td>
<td>Colour Bands to BS. 4800</td>
</tr>
<tr>
<td>----------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Oils:</strong></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>00 E 55</td>
</tr>
<tr>
<td>Lubricating</td>
<td>14 E 53</td>
</tr>
<tr>
<td>Hydraulic Power</td>
<td>04 C 53</td>
</tr>
<tr>
<td>Transformer</td>
<td>04 D 45</td>
</tr>
<tr>
<td><strong>Drainage and other fluids:</strong></td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Electrical Services</td>
<td>Basic Colour only</td>
</tr>
</tbody>
</table>

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:-

- High Temperature Hot Water: HTHW
- Medium Temperature Hot Water: MTHW
- Low Temperature Hot Water: LTHW
- Chilled Water: CHW
- Condenser Water: CONDW
- Steam: ST
- Condensate: CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

### ii. Duct Work Services:

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

<table>
<thead>
<tr>
<th>Services</th>
<th>Colour</th>
<th>BS.4800 Colour Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned Air</td>
<td>Red and Blue</td>
<td>04 E 53 / 18 E 53</td>
</tr>
<tr>
<td>Ward Air</td>
<td>Yellow</td>
<td>10 E 53</td>
</tr>
<tr>
<td>Outdoor air</td>
<td>Green</td>
<td>14 E 53</td>
</tr>
<tr>
<td>Exhaust / Extract / Recirculated Air</td>
<td>Grey</td>
<td>AA 0 09</td>
</tr>
<tr>
<td>Foul Air</td>
<td>Brown</td>
<td>06 C 39</td>
</tr>
<tr>
<td>Dual Duct System Hot Supply Air</td>
<td>Red</td>
<td>04 E 53</td>
</tr>
<tr>
<td>Cold Supply Air</td>
<td>Blue</td>
<td>18 E 53</td>
</tr>
</tbody>
</table>

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

- Supply Air: S
- Return Air: R
- Outdoor Air: O
- Exhaust Air: E
- Smoke Extract Duct: M
- Spill Air: A

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

K) **LIST OF ABBREVIATIONS**
Followings List of Abbreviations shall have been used in preparing the Tender Specifications, Bill of Quantities & Drawings.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AABC</td>
<td>AMERICAN AIR BALANCING COUNCIL</td>
</tr>
<tr>
<td>ACH</td>
<td>AIR CHANGE PER HOUR</td>
</tr>
<tr>
<td>AC</td>
<td>AIR CONDITIONING</td>
</tr>
<tr>
<td>ACMV</td>
<td>AIR CONDUCTING AND MECHANICAL VENTILATION</td>
</tr>
<tr>
<td>AHU</td>
<td>AIR HANDLING UNIT</td>
</tr>
<tr>
<td>ANSI</td>
<td>AMERICAN NATIONAL STANDARD INSTITUTE</td>
</tr>
<tr>
<td>ARI</td>
<td>AMERICAN REFRIGERATION INSTITUTE</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING ENGINEER</td>
</tr>
<tr>
<td>ASME</td>
<td>AMERICAN SOCIETY OF MECHANICAL ENGINEERS</td>
</tr>
<tr>
<td>ASTA</td>
<td>ASSOC.IATION OF SHORT - CIRCUIT TESTING AUTHORITIES</td>
</tr>
<tr>
<td>ASTM</td>
<td>AMERICAN SOCIETY OF TESTING AND MATERIALS</td>
</tr>
<tr>
<td>ATG</td>
<td>AIR TRANSFER GRILLE</td>
</tr>
<tr>
<td>AWS</td>
<td>AMERICAN WELDING SOCIETY</td>
</tr>
<tr>
<td>BAS</td>
<td>BUILDING AUTOMATION SYSTEM</td>
</tr>
<tr>
<td>BIS</td>
<td>BUREAU OF INDIAN STANDARD</td>
</tr>
<tr>
<td>BMS</td>
<td>BUILDING MANAGEMENT SYSTEM</td>
</tr>
<tr>
<td>BTU</td>
<td>BRITISH THERMAL UNIT</td>
</tr>
<tr>
<td>CDW</td>
<td>CONDENSER WATER</td>
</tr>
<tr>
<td>CFM</td>
<td>CUBIC FEET PER MINUTE</td>
</tr>
<tr>
<td>CHW</td>
<td>CHILLED WATER</td>
</tr>
<tr>
<td>CMS</td>
<td>CENTRAL MONITORING SYSTEM</td>
</tr>
<tr>
<td>CRCA</td>
<td>COLD ROLLED COLD ANNEALED</td>
</tr>
<tr>
<td>CSA</td>
<td>CANADIAN STANDARD ASSOC.IATION</td>
</tr>
<tr>
<td>CT</td>
<td>COOLING TOWER</td>
</tr>
<tr>
<td>CTI</td>
<td>COOLING TOWER INSTITUTE</td>
</tr>
<tr>
<td>DB</td>
<td>DISTRIBUTION BOARD</td>
</tr>
<tr>
<td>DDC</td>
<td>DIRECT DIGITAL CONTROLLER</td>
</tr>
<tr>
<td>DOL</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>DFA</td>
<td>Delhi Fire Authority</td>
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<tr>
<td>DIA</td>
<td>Diameter</td>
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<tr>
<td>DIDW</td>
<td>Double Inlet Double Width</td>
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<td>DX</td>
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<td>EA</td>
<td>Exhaust Air</td>
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<tr>
<td>EEPROM</td>
<td>Electrical Erasable Program</td>
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<td>ELCB</td>
<td>Earth Leakage Circuit Breaker</td>
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<tr>
<td>ETL</td>
<td>Electrical Testing Laboratories</td>
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<td>EPA</td>
<td>Environmental Protection Act</td>
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<td>FCU</td>
<td>Fan Coil Unit</td>
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<tr>
<td>F/A</td>
<td>Floor Above</td>
</tr>
<tr>
<td>F/B</td>
<td>Floor Blow</td>
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<tr>
<td>FCC</td>
<td>Fire Command Centre</td>
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<td>FD</td>
<td>Fire Damper</td>
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<td>FFL</td>
<td>Finished Floor Level</td>
</tr>
<tr>
<td>FPM</td>
<td>Feet Per Minute</td>
</tr>
<tr>
<td>FPS</td>
<td>Foot Per Second</td>
</tr>
<tr>
<td>FRP</td>
<td>Fiberglass Reinforced Plastic</td>
</tr>
<tr>
<td>GI</td>
<td>Galvanized Iron</td>
</tr>
<tr>
<td>GPM</td>
<td>Gallon Per Minute</td>
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<tr>
<td>GSS</td>
<td>Galvanized Steel Sheet</td>
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<td>Hot Dip Galvanized</td>
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<td>High Density Poly Ethane</td>
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<td>Hydro Fluoro Carbon</td>
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<tr>
<td>HP</td>
<td>Horse Power</td>
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<tr>
<td>HVAC</td>
<td>Heating, Ventilation &amp; Air Conditioning</td>
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<tr>
<td>IAQ</td>
<td>Indoor Air Quality</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrochemical Commission</td>
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<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>IKW</td>
<td>INDICATED KILO WATT</td>
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<td>IPD</td>
<td>INITIAL PRESSURE DROP</td>
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<td>LOW SMOKE ZERO HALOGEN</td>
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<td>LOW TENSION</td>
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<tr>
<td>MIN</td>
<td>MINIMUM</td>
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<tr>
<td>MM</td>
<td>MILLIMETER</td>
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<tr>
<td>NBC</td>
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<td>NOISE CRITERIA</td>
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<tr>
<td>NEC</td>
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<td>NFPA</td>
<td>NATIONAL FIRE PROTECTION ASSOC.ATION</td>
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<tr>
<td>NPLV</td>
<td>NET PART LOAD VALUE</td>
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<td>NIST</td>
<td>NATIONAL INSTITUTE OF STANDARDS &amp; TECHNOLOGY</td>
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<td>NEMA</td>
<td>NATIONAL ELECTRICAL MANUFACTURERS ASSOC.ATION</td>
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<td>NPSH</td>
<td>NET POSITIVE SUCTION HEAD</td>
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<td>NTS</td>
<td>NOT TO SCALE</td>
</tr>
<tr>
<td>OA</td>
<td>OUTDOOR AIR</td>
</tr>
<tr>
<td>PHE</td>
<td>PUBLIC HEALTH ENGINEERING</td>
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<tr>
<td>PLC</td>
<td>PROGRAMMABLE LOGIC CONTROLLER</td>
</tr>
<tr>
<td>P.C.</td>
<td>PERSONAL COMPUTER</td>
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<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>PSIG</td>
<td>POUNDS PER SQUARE INCH GAUGE</td>
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<tr>
<td>PUF</td>
<td>POLYURETHANE FOAM</td>
</tr>
<tr>
<td>RA</td>
<td>RETURN AIR</td>
</tr>
<tr>
<td>RAD</td>
<td>RETURN AIR DUCT</td>
</tr>
<tr>
<td>RCC</td>
<td>REINFORCED CEMENT CONCRETE</td>
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<tr>
<td>RH</td>
<td>RELATIVE HUMIDITY</td>
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<tr>
<td>RPM</td>
<td>REVOLUTIONS PER MINUTE</td>
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<td>SA</td>
<td>SUPPLY AIR</td>
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<td>SAD</td>
<td>SUPPLY AIR DUCT</td>
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<td>SHEET METAL &amp; AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION INC</td>
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<td>STANDARD</td>
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<td>TO ABOVE</td>
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<td>TAB</td>
<td>TESTING, ADJUSTING AND BALANCING</td>
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<td>TO BELOW</td>
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<td>TCC</td>
<td>TERMINAL CONTROL CENTRE</td>
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<td>TFA</td>
<td>TREATED FRESH AIR</td>
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<td>TOA</td>
<td>TREATED OUTDOOR AIR</td>
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<tr>
<td>TP</td>
<td>THREE PHASE</td>
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<td>TR</td>
<td>TONS OF REFRIGERATION</td>
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<td>TVOC</td>
<td>TOTAL VOLATILE ORGANIC COMPOUNDS</td>
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<td>VAV</td>
<td>VARIABLE AIR VOLUME</td>
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<td>VFD</td>
<td>VARIABLE FREQUENCY DRIVES</td>
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<td>VIP</td>
<td>VIBRATION ISOLATING PAD</td>
</tr>
<tr>
<td>VSPS</td>
<td>VARIABLE SPEED PUMPING SYSTEM</td>
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<tr>
<td>XLPE</td>
<td>CROSS-LINKED POLYETHYLENE</td>
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<tr>
<td>SISW</td>
<td>SINGLE INLET SINGLE WIDTH</td>
</tr>
<tr>
<td>UL</td>
<td>UNDERWRITERS LABORATORIES INC.</td>
</tr>
<tr>
<td>WG</td>
<td>WATER GAUGE</td>
</tr>
</tbody>
</table>
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

1. PERFORMA OF TECHNICAL DATA TO BE FILLED UP BY THE AC CONTRACTOR

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme, specification, bill of quantities given in the tender.

| i) Water-cooled Rotary Screw Water Chilling Machine (AHRI Certified) |
|---|---|

Kindly Attach the Following.

1. Computer Selection of the Unit
   Along With Part Load Performance at Constant Condenser Water Inlet
2. Details of safeties and protection.
3. Detailed functions of Microprocessor Controller

i. Compressor

<table>
<thead>
<tr>
<th>a) Manufacture Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) Model</td>
</tr>
<tr>
<td>c) Type of Compressor</td>
</tr>
<tr>
<td>Hermetic/ Semi-hermetic / Open</td>
</tr>
<tr>
<td>d) No. of Compressor per Machine</td>
</tr>
<tr>
<td>e) Nominal Capacity of Each Compressor in TR</td>
</tr>
<tr>
<td>f) Nominal Capacity of Chilling Machine</td>
</tr>
</tbody>
</table>

Operating Conditions

| g) Saturated Suction Temperature Deg. C. |
| h) Saturated Discharge Temperature Deg. C. |
| i) Max. RPM |
| j) Mode of start |
| k) Refrigerant used |
| l) Qty. of Refrigerant used |
| m) Power consumption IKW/TR At Full Load 100 % |
| 90 % |
| 80 % |
| 70 % |
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

60 % : 
50 % : 
40 % : 
30 % : 
20 % : 
n) NPLV of the M/C : 
o) Type of capacity control : 
p) Range of capacity variation : 
q) Monitoring Devices : 
r) Type of bearings : 

ii. Motor (Compressor)

a) Make of Motor : 
b) Type of Motor : 
c) Motor KW : 
d) Class of Insulation : 
e) R.P.M. : 
f) Type of starter (Star Delta or Part Winding) : 
g) Electrical characteristics 
   Voltage / Frequency : 
   Fluctuations permissible : 
j) Full load current (Amp) : 
k) Starting current (Amp) : 
l) Type of Vibration 
   Isolator for Chillers 
   Recommended by manufacturer : 

iii. Condenser

a) Manufacture Name : 
b) Model : 
c) Number of Condensers : 
d) Fouling Factor MKS. : 
e) Heat rejection capacity Kcal / hr. : 
f) Pressure Drop Mts. :
g) Water flow rate (LPM) : 

h) No. of passes : 

i) Water temperature in °C : 

j) Water temperature out °C : 

iv. Chiller

a) Manufacturer Name : 

b) Model : 

c) Type of chiller : 

d) Water Flow LPM : 

e) No. of Passes : 

f) Water Temperature Out °C : 

g) Water Temperature In °C : 

h) Pressure Drop in Mt. of water : 

i) Cooling Capacity Kcal / Hr. : 

j) Fouling factor MKS : 

v. Overall Size of Water Chilling Machine

a) Overall dimension MM : 

b) Operating Wt. Kg. : 

c) Service Clearance required in mm : 

vi. Water Chilling Machine

a) Operating Conditions : 

b) Actual Capacity of water
   Chilling machine at above
   Operating conditions

   ii) Cooling Tower

a) Make of cooling Tower : 

b) Type of cooling Tower : 

c) Model of cooling Tower : 

d) Capacity of Cooling Tower : 

e) Approach of cooling tower : 

f) Wet Bulb (Design) : 

g) Fan Motor (Type & Rating) : 

h) Fan Diameter (Each) : 

i) Fan Capacity (Each) : 

j) Material of casing & basin : 

k) Overall dimension in MM : 

l) Dry weight KG : 

m) Operating weight : 

n) Water flow rate USGPM : 

o) No. of fans : 

p) R.P.M. of Motor : 

q) Drift loss : 

r) Evaporation loss : 

s) Total Water Loss in LPH : 

t) Type of drive : 

iii) Chilled Water Primary Pump Sets 

a) Make : 

b) Type : 

c) Model : 

d) Discharge (LPM) : 

e) Head (Mt) : 

f) Efficiency : 

g) Brake Horse Power : 

h) Horse power of motor : 

i) Make / Type of motor : 

j) Impeller Diameter (MM) & Material : 

k) Material of Bearing / Seal : 

l) Type of Bearing / Seal : 

m) Speed (RPM) : 
<table>
<thead>
<tr>
<th>Material of Shaft</th>
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<th>iv) Condenser Water Pump Sets</th>
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<tbody>
<tr>
<td>a) Make</td>
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<tr>
<td>b) Type</td>
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<tr>
<td>c) Model</td>
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<tr>
<td>d) Discharge (LPM)</td>
</tr>
<tr>
<td>e) Head (Mt)</td>
</tr>
<tr>
<td>f) Efficiency</td>
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<tr>
<td>g) Brake Horse Power</td>
</tr>
<tr>
<td>h) Horse power of motor</td>
</tr>
<tr>
<td>i) Make / Type of motor</td>
</tr>
<tr>
<td>j) Impeller Diameter (MM) &amp; Material</td>
</tr>
<tr>
<td>k) Material of Bearing / Seal</td>
</tr>
<tr>
<td>l) Type of Bearing / Seal</td>
</tr>
<tr>
<td>m) Speed (RPM)</td>
</tr>
<tr>
<td>n) Material of Shaft</td>
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<table>
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<tr>
<th>v) Secondary Chilled Water Pump Sets</th>
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<tbody>
<tr>
<td>a) Make</td>
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<tr>
<td>b) Type</td>
</tr>
<tr>
<td>c) Model</td>
</tr>
<tr>
<td>d) Discharge (LPM)</td>
</tr>
<tr>
<td>e) Head (Mt)</td>
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<tr>
<td>f) Efficiency</td>
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<tr>
<td>g) Brake Horse Power</td>
</tr>
<tr>
<td>h) Horse power of motor</td>
</tr>
<tr>
<td>i) Make / Type of motor</td>
</tr>
<tr>
<td>j) Impeller Diameter (MM) &amp; Material</td>
</tr>
<tr>
<td>k) Material of Bearing / Seal</td>
</tr>
<tr>
<td>l) Type of Bearing / Seal</td>
</tr>
</tbody>
</table>
m) Speed (RPM) :

n) Material of Shaft :

vi) Variable Speed Pumping System

a) Make :

b) No. of Adjustable Frequency Drives :
   Suitably interfaced with other system Components. Hand / Auto macro
   Designed for pumping system

c) Capacity of AFD :

d) No. of Pump Logic Controller :

e) Pumping Software duly downloaded :

f) DP Sensor / Transmitter :

g) Interfacing amongst all components
   & compatibility of I/O signals

vii) Pressure Independent Balancing Cum Control Valves

a) Make / Model of valve :

b) Make / Model of Modulating motor :

c) Voltage of motor :

d) Transformer Provided :

e) Valve linkage :

f) Pressure Rating :

viii) Pipes

a) Make :

b) Class :

c) Wall Thickness mm :

<table>
<thead>
<tr>
<th>Nominal Pipe Dia in mm</th>
<th>Wall Thickness of Pipe in mm</th>
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<tbody>
<tr>
<td>25</td>
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<tr>
<td>32</td>
<td>:</td>
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<td>40</td>
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<tr>
<td>50</td>
<td>:</td>
</tr>
<tr>
<td>65</td>
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<tr>
<td>80</td>
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<table>
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<th>Nominal Pipe Dia in mm</th>
<th>Wall Thickness of Pipe in mm</th>
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ix) Valves
a) Check Valve make :

b) Butterfly Valve make :

c) Automatic Balancing Valve make :

d) Y-Strainer Make & Model :

e) Pot-Strainer Make & Model :

f) Pressure Rating :

x) Duct Insulation
a) Manufactures Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal / Hr. Deg. C. :

e) Facing / finish of Insulation :

xi) Duct Lining
a) Manufactures Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal / Hr. Deg. C. :

xii) Pipe Insulation
a) Manufactures Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal / Hr. Deg. C. :
xiii) **Electrical Accessories**

Please indicate the makes of the following.

a) **Panel Manufacturer’s name**: 

xiv) **Axial Flow Fan**

a) Manufactures Name : 
b) Capacity CMH : 
c) Static Pressure : 
d) Motor BHP & HP : 
e) Fan Diameter mm : 
f) Efficiency of Fan : 
g) dB level at 2.5 Meter : 
h) RPM of Fan :

xv) **Centrifugal Fan**

a) Manufactures Name : 
b) Capacity CMH : 
c) Static Pressure : 
d) Motor BHP & HP : 
e) Fan Diameter mm : 
f) Efficiency of Fan : 
g) dB level at 2.5 Meter : 
h) RPM of Fan :

xvi) **Air Handling Unit**

i. **General**

a) Make of AHU : 
b) Capacity CMH : 
c) Material/Gauge (Casing Drain Pan) : 
d) Over all size L x B x H mm : 
e) Type of AHU, Vertical / Horizontal / Ceiling Suspended :
f) Over all Weight in Kg. : 

ii. Cooling Coil
   a) Make : 
   b) Material of tube/fins : 
   c) No. of fins/cm : 
   d) No. of rows deep : 
   e) Dia of tubes (MM) : 
   f) Face area(SMT) : 
   g) Cooling capacity (Kcal/hr) : 
   h) chilled water flow rate, LPM : 
   i) Face velocity MPS : 
   j) Test pressure Kg/cm2 : 

iii. Filter Section
   a) Make : 
   b) Type of filters : 
   c) No. of filters : 
   d) Size of filters : 
   e) Air velocity through filter FPM : 
   f) Efficiency of filter % : 

iv. Fan & Fan Motor
   a) Make of Fan & Motor : 
   b) Type of fan : 
   c) No. of fans : 
   d) Width and dia of fans (MM) : 
   e) Type of blade : 
   f) Air quantity CMH : 
   g) Static pressure in wg : 
   h) Type of balancing : 
   i) Brake horse power in HP :
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>j)</td>
<td>Horse power of motor in HP</td>
<td></td>
</tr>
<tr>
<td>k)</td>
<td>Motor RPM</td>
<td></td>
</tr>
<tr>
<td>l)</td>
<td>Fan speed</td>
<td></td>
</tr>
<tr>
<td>m)</td>
<td>Type of Drive (Belt Driven / Direct Driven)</td>
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</tr>
<tr>
<td></td>
<td><strong>Scrubber</strong></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Make of Scrubber &amp; fan</td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Type of fan</td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>No of fans per Scrubber</td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Capacity of each fan in CMH</td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>BKW of each fan</td>
<td></td>
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<tr>
<td>f)</td>
<td>Motor HP of fan</td>
<td></td>
</tr>
<tr>
<td>g)</td>
<td>No of pump in each Scrubber</td>
<td></td>
</tr>
<tr>
<td>h)</td>
<td>HP of each pump</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Make of cooling media</td>
<td></td>
</tr>
<tr>
<td>j)</td>
<td>Face velocity across media</td>
<td></td>
</tr>
<tr>
<td>k)</td>
<td>Total area of media</td>
<td></td>
</tr>
<tr>
<td>l)</td>
<td>Material &amp; Size of filters</td>
<td></td>
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<tr>
<td>m)</td>
<td>Area of filters</td>
<td></td>
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<tr>
<td>n)</td>
<td>Efficiency &amp; filtration capacity of filters</td>
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<tr>
<td>o)</td>
<td>Efficiency of Scrubber</td>
<td></td>
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<tr>
<td>p)</td>
<td>Material of casing of Scrubber</td>
<td></td>
</tr>
<tr>
<td>q)</td>
<td>Thickness of casing of Scrubber</td>
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<tr>
<td></td>
<td><strong>Hot Water Pump Sets</strong></td>
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</tr>
<tr>
<td>a)</td>
<td>Make</td>
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</tr>
<tr>
<td>b)</td>
<td>Type</td>
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<tr>
<td>c)</td>
<td>Model</td>
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<td>d)</td>
<td>Discharge (LPM)</td>
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<td>e)</td>
<td>Head (Mt)</td>
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<tr>
<td>f)</td>
<td>Efficiency</td>
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</tbody>
</table>
g) Brake Horse Power : 

h) Horse power of motor : 

i) Make / Type of motor : 

j) Impeller Diameter (MM) & Material : 

k) Material of Bearing / Seal : 

l) Type of Bearing / Seal : 

m) Speed (RPM) : 

n) Material of Shaft : 

xix) Air Washers

a) Make of AWS & fan : 

b) Type of fan : 

c) No of fans per AWS : 

d) Capacity of each fan in CMH : 

e) BKW of each fan : 

f) Motor HP of fan : 

g) No of pump in each AWS : 

h) HP of each pump : 

i) Make of cooling media : 

j) Face velocity across media : 

k) Total area of media : 

l) Material & Size of filters : 

m) Area of filters : 

n) Efficiency & filtration capacity of filters : 

o) Efficiency of AWS : 

p) Material of casing of AWS : 

q) Thickness of casing of AWS : 

xx) Hot Water Generator

a) Make : 

...
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

b) Capacity : 

c) No. of Bank : 

xxi) Inline Fans

a) Manufactures Name : 

b) Capacity CMH : 

c) Static Pressure : 

d) Motor BHP & HP : 

e) Fan Diameter mm : 

xxii) Grills / Diffusers / Dampers

Please indicate make / material / gauge of the following:

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Duct Dampers :</td>
<td></td>
</tr>
<tr>
<td>b) Grills / Diffusers :</td>
<td></td>
</tr>
<tr>
<td>c) Fire Dampers :</td>
<td></td>
</tr>
<tr>
<td>d) Smoke &amp; Temperature Sensor :</td>
<td></td>
</tr>
<tr>
<td>e) Volume Control Dampers :</td>
<td></td>
</tr>
</tbody>
</table>

xxiii) Filters / Fine Filters

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
<th>Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Make of filters :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Frame of filters :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Media of filters :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Capacity of filters (CMH) :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Efficiency :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Particle size :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Pressure drop when clean in mm :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Pressure drop when choked :</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

xxiv) Fan Coil Unit

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Air quantity CFM :</td>
<td></td>
</tr>
<tr>
<td>b) Fan Static pressure (External) in mm :</td>
<td></td>
</tr>
<tr>
<td>c) Face area of Cooling Coil :</td>
<td></td>
</tr>
</tbody>
</table>
### d) Minim. no. of fins / cm

### e) No. of rows deep

### f) Motor HP

### g) Sandwiched tray

### h) Type of painting

### i) Noise Level in db at a distance of 1.0 m

### k) Make

#### xxv) Thermostat / Humidistat

| a) Make | : |
| b) Whether digital or analogue | : |
| c) Model | : |
| d) Technical catalogue enclosed, yes / no | : |

#### xxvi) VAV UNITS

| a) Manufactures Name | : |
| b) Capacity CFM (Minm.) | : |
| c) Capacity CFM (Max.) | : |
| d) Bypass Arrangement (Yes/No) | : |
| e) Dimension (LxWxH) MM | : |
| f) Operating Wt., Kg | : |
| g) Wall Mounted Control Panel (Yes/No) | : |
ELECTRICAL WORK
SUBJECT: Proposed Electrical Work for Medical College & Hospital at Sundergarh, Odisha.

INTRODUCTION: It is proposed to supply, installation, testing and commissioning electrical work D.G. Set, Exhaust Piping, Exhaust Piping Insulation, D.G. Set neutral & body earthing, Bus Duct / Cabling, Synchronizing Panel, 33KV/0.415KV Substation, Main L.T. Panel, Floor Distribution Panel & Distribution Board, Main & Sub main Cables, Point Wiring, Light Fixture, Telephone System, Data Cabling Network, Addressable Fire Detection System, Public Address System, CCTV System, Lightning Protection System, UPS System, Earthing, Access Control System & External Lighting System etc. as per Schedule of Quantities given in the tender. The Electrical Work shall comprise of following.

a) Supply of D.G. Set
b) Installation of D.G. Set.
c) Bus Duct / Cabling
d) D.G. Set Aux. Panel.
e) Earthing System.
f) D.G. Set Exhaust Piping
g) Safety Equipment
h) SIT&C of 33KV/0.415KV Substation
i) Synchronizing Panels
j) Main L.T. Panels
k) Bus Duct
l) Floor Distribution Panel
m) Distribution Boards
n) Main & Sub main Cables
o) Point Wiring
p) Light Fixtures
q) Telephone System
r) Data cabling Network
s) Addressable Fire Detection System
t) Public Address System
u) CCTV System
v) Lightning Protection System
w) UPS System
x) Access Control System
y) External Lighting
z) All other item as detailed in Schedule of Quantities.
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

INTRODUCTION
A centralised electrical system shall be designed, installed & commissioned to provide the electrical power for Medical College & Hospital at Sundergarh, Odisha.

OUTSIDE DESIGN CONDITION

<table>
<thead>
<tr>
<th>Minimum Temperature</th>
<th>Maximum Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C</td>
<td>50</td>
</tr>
</tbody>
</table>

LOCATION OF D.G. SET & SUBSTATION:
D.G. Set shall be installed on Ground Floor Level as per drawing attached.

CAPACITY OF D.G. SET:
2x1000 KVA + 1x600 KVA, 415 Volt radiator cooled D.G. Set with acoustic enclosure shall be installed on Ground Floor Level to provide the power backup as per requirement in case of power cut / break down of Grid Supply.

CAPACITY OF 33KV / 0.415KV SUBSTATION:
3x1750 KVA, 33KV/0.415KV, 3 Phase, 4 Wire, 50 Hz, Oil type transformer with on load tap changer shall be installed on Ground Floor Level to provide the power to entire complex with required H.T. Panel etc.

STARTING METHOD FOR D.G. SET:
D.G. set shall be suitable for Manual/Auto start through D.G. Set Controller and shall be compatible for synchronizing through Synchronizing relay.

D.G. COOLING METHOD:
D.G. Set shall be radiator cooled.

EARTHING SYSTEM:
The earthing system to be provided for the D.G. set system as required as per IS: 3048.

D.G. SYNCHRONIZING PANEL:
D.G. Synchronizing Panel shall be installed in D.G. Room for synchronization of D.G. Sets.

Main L.T. PANEL:
Main L.T. Panel to be installed in D.G. Room for changeover the power and power distribution for entire building.

CAPACITOR PANEL:
Capacitor Panel to be installed to improve the power factor as per norms of SEB.
TECHNICAL SPECIFICATION OF EQUIPMENTS
D.G. SET

INTENT OF SPECIFICATION:

This specification covers the design, manufacture, assembly, shop testing, packing, dispatch, transportation supply, erection, testing, commissioning, performance and guarantee testing of Diesel Gen-Sets, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

CODES AND STANDARDS:

The equipment furnish under this specification shall conform to the following latest standard, except where modified or supplemented by this specification:

- BS:5514 : Specification for reciprocating internal combustion engine.
- BS:5000 : Rotating electrical machines of particular type or for particular applications.
- IS:1239 (Part - I&II): Mild steel tubes and fittings.
- IS:1651 : Stationary cells and batteries lead acid type (with tubular positive plates).
- IS:4540 : Mono-crystalline semi-conductor rectifier assemblies and equipment.
- IS:5 : Colours for ready mixed paints.
- IS:4722 : Rotating electrical machines
- IS:10000 : Methods of tests for internal combustion engines.
- IS:10002 : Specifications for performance requirements for constant speed compression ignition (Diesel) engine for general purposes (above 20 KW).
- IS:2147 : Degree of protection provided by enclosure for low voltage switchgear and control gear.
- IS:1600 : Code for type testing of constant speed IC engines for general purposes.
- IS:1601 : Performance of constant speed IC engines for general purposes.
- ASME Power Test Code PTC-17 : Internal combustion engines.

ENGINE:

Diesel Engine shall be stationary, compression, ignition, totally enclosed, water cooled, stroke cycle, cold battery starting, turbo charged and after cooled heat exchanger cooled 1500 RPM in accordance to BS and IS specification complete with all accessories

COOLING SYSTEM:

Cooling system shall be radiator cooled.
FUEL SYSTEM:

Fuel System shall have PT Fuel Pump, Injectors, Fuel filters, Self contained piping & houses, Complete piping.

LUBRICATING SYSTEM:

Lubricating system shall have Oil pump, Strainer, Lube oil cooler, Oil filter, Bypass filter, Self contained piping, Lube oil priming pump.

AIR INTAKE SYSTEM:

Air intake system shall have dry type filter, Air intake manifold with necessary connections, Turbocharger with after cooler.

EXHAUST SYSTEM:

Exhaust system shall have Exhaust Manifold, Flexible piping, Hospital silencer to limit the noise level and extending silencer outside the canopy.

STARTING SYSTEM:

Starting system shall have Starter 24V with suitable ampere capacity, Charging Alternator with inbuilt regulator 24 V minimum 30 AMP DC or as per battery capacity, Connecting links between battery & alternator. The engine shall be suitable for black start.

MAIN AND BIG END BEARING:

The main and big end bearing shall be detachable shells of high grade bearing material, and shall be pre finished. The dimensions of big end bearings shall be such that the connecting rods can be withdrawn through the cylinder liners.

COUPLING ARRANGEMENT:

Coupling arrangement shall have Flexible coupling, Flywheel, Flywheel Housing, Coupling Guard

INSTRUMENT PANEL:

Instrument Panel shall have-
- Lube oil pressure gauge
- Water temperature gauge
- RMP Indicator & Hour Meter.
- Battery charger ammeter.
- Starting switch with key

SAFETY CONTROL TRIP:

- Low Lube oil pressure
- High Water temperature
- Engine over speed.
- Lub oil temperature.

ALTERNATOR:

Output : 1010 KVA / 600 KVA self excited, self regulated foot mounted fitted with ball and roller bearings and having PMG, droop CT for paralleling. This shall give full output of 1010KVA / 600 KVA at 40 deg. C.
Power factor : 0.8

Rated Generating Voltage : 415 Volts, 3 phase 4 wire system

Voltage regulation : +/- 1.0% all load between no load to full load & power factor 0.8 to unity. AVR shall be mounted in alternator.

Frequency : 50 HZ

Speed : 1500 RPM

Overload Capacity : 10% for one hour in any 12 hours of operation without exceeding temperature rise limits specified in BS: 2613 when corrected to ambient temperature at site

Class of Insulation : H and temperature rise limited to class H

Space Heater : To be provided

Winding connection : Star connection (all six leads will be brought out of stator frame).

Termination : Termination box shall be amended to connect the bus duct.

The alternator shall be self-excited, self regulated, self ventilated in brush less for suitable automatic voltage regulator and shall conform to BS: 2613 or equivalent standard and shall give rated output at NTP conditions. The alternator shall have space heater which shall be connected with breaker NO/NC contacts and this should be able to cut off with thermostat.

OTHER ACCESSORIES:

FUEL TANK:

Day service fuel tank shall be made of 3mm thick MS sheet of 990 litres capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect split oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings interconnections between tanks. The tank shall be provided with suitable calibration scale.

BASE FRAME:

M.S. Fabricated adequately machined base frame complete with lifting, facilities pre-drilled foundation holes suitable for permanent installation on foundation shall also be supplied. The base frame shall be manufactured with steel and shall be stress relieved. Manufacturer shall specify what measures are taken to reduce the stresses.

BATTERIES

For electrical control ckt of 24V D.C. of suitable ampere hour complete with battery charger, leads and wooden base plate and shall be placed inside canopy.

FUEL SYSTEM:

The engine shall be capable of running on High Speed Diesel fuel oil. The fuel consumption of the engine at full, three quarters and half of its rated power output shall be indicated by the Contractor in the bid. A fuel service buffer tank, common for two DG set with 990 litres capacity shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. Service tank level switches (2 Nos. per tank) for alarm & trip shall also be provided.
by the bidder. All pipe joints should be brazed/welded. A hand pump for pumping the fuel into the fuel service tank together with necessary pipes or tubing shall be provided.

**SILENCER:**

Exhaust silencer shall be residential type to reduce the noise level.

**COOLING:**

The diesel engine shall be radiator cooled.

**ENGINE GOVERNER:**

The governor shall be Electronic type suitable for class A-1. This shall control the generator frequency, and shall be suitable for operation as per the selected battery voltage (24 V DC). The governor shall be provided with a manually adjustable over speed trip mechanism to automatically shut-off the engine or the fuel supply if the set reached 120% of rated speed. Governor shall be capable to maintain zero speed rate or regulation and shall be Al type as per BS:5514 in order to take care of heavy motor starting. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit.

**TURBO CHARGER:**

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

**STARTER BATTERY:**

The battery shall conform to the requirement of IS: 1651. Starting battery sets of 24 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery shall be capable of performing at least (6) six normal starts without recharging.

The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy duty PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.

The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.

**ENGINE SAFEGAURD:**

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

Energising a solenoid coupled to the stop lever on the fuel injection pump rack.
De-energising the “fuel on” solenoid
Energising the “fuel - cut off” solenoid.
If any of the door opens.

The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.

The contactors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.

At the set at a easily accessible place an “EMERGENCY STOP” mushroom head stay put type P.B shall provided to stop the set in emergency mode.
The safe guard to “STOP THE SET” shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator ckt.

Emergency stop P.B’s operation
Over speed.
Low lube oil pressure.

SOUND ATTENUATING ACOUSTIC ENCLOSURE:

Sound Attenuating Acoustic Enclosure should have pleasant and aesthetical looks and should be able to bring down the noise to 72 decibels when measured at a distance of 1 meter away from the set.

The DG set should be supported on a base frame in an MS Sheet enclosure with suitable ducting for air inlet and outlet. The door and enclosure should be given corrosion resistant treatment and painted to be weatherproof and long lasting. Resin bonded Glass / Mineral / Rock wool of high density (greater than 45 Kg / Cu. M) with minimum thickness of 75 mm covered with perforated MS Sheet should be provided and covered with tissue paper. Enclosures should be provided with durable locking system with doors duly gasketed with neoprene rubber.

Exhaust gases should be taken out from the DG Set by means of MS Pipe and a noise suppressor.

Proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc, as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than 7°C.

Radiator hot air shall be throughout on top instead of front. The arrangement to be made accordingly in acoustic enclosure.

ERECTION, TESTING & COMMISSIONING OF D.G. SETS:

ERECTION, TESTING, COMMISSIONING AND PERFORMANCE OF DG TESTS:

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommend by the contractor.

The successful contractor shall submit sufficiently in advance the bio-data of the supervisor giving details of his experience for Owner’s approval.

The contractor shall ensure that the equipment supplied by him are installed in a neat workman like manner such that they are leveled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor. The bid shall include a list of these special tools, tackles and spares along with their item wise prices. The total cost for these tools, tackles and spares shall be included in the bid price.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.
COMMISSIONING CHECK TESTS / PERFORMANCE AND GUARANTEE TEST:

In addition to the checks and tests recommended by the manufacturer, the contractor shall supervise the following acceptance tests to be carried out on each test.

LOAD TEST:

The engine shall be given test run for a period of at least 6 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.

This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator and exciter shall be satisfactory at the end of this overload run.

At the end of the full-load run, and again at the end of the over-load run, tests for temperature rise and insulation resistance of the alternator as specified shall be taken.

Full load test can be performed at site or at manufacturer’s works before dispatch and shall be monitored by the Client/Consultants/Representative.

During the load test half hourly records of the following shall be taken:

Ambient temperature
Exhaust temp when exhaust thermometer is fitted.
Cooling water temp at a convenient point adjacent to the water output from the engine jacket.
Lubricating oil temperature when an oil cooler is fitted.
Lubricating oil pressure.
Speed
Voltage, wattage and current output.
Oil tank level
Colour of exhaust gas
Stored diesel oil temperature

INSULATION RESISTANCE TEST FOR ALTERNATOR:

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500 Volts megger shall not be less than

\[ IR = 2 \times (\text{rated voltage in KV}) + 1 \]

REGULATION TEST:

The automatic and manual regulation of the alternator load at half and full rated load shall be tested for a nominal volts of 240 Volts, between phase to neutral and at 0.8 p. f. to verify the requirements of voltage and frequency variation as per IS:4722.

SPEED AND GOVERNING:

The speed of the engine shall be verified to ensure that it conforms to the requirement of BS:5514.

VIBRATION:

The vibrations shall be measured during full load test as well as during the overload test and the limit shall be as per IS.

CHECK FOR FUEL CONSUMPTION:

A check of the fuel consumption shall be made throughout the test run of full load and overload. The D.G. Set shall generate 4 unit / litre under 40% to 100% load condition.
NOISE LEVEL:

The equivalent ‘A’ weighted sound level measured at a distance of 1 meter horizontally from the base of any equipment furnished and installed under these specifications expressed in decibels to a reference of 0.0002 microbar, shall not exceed 75 DB.

SPARE PARTS FOR DG SETS:

MANDATORY SPARE PARTS:

The list of mandatory spares to be submitted by the contractor to owner along with bid.

CABLE WORK

DESCRIPTION OF WORK

Supply, laying, testing and commissioning of cables as per specifications, schedule of quantities and drawings.

APPLICABLE CODES & STANDARDS

<table>
<thead>
<tr>
<th>Code/Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS: 10242 (Part-3, Section-12)</td>
<td>Installation of cables for low voltage System</td>
</tr>
<tr>
<td>Part-I</td>
<td>For working voltages up to &amp; including 1100 Volts.</td>
</tr>
<tr>
<td>Part-II:</td>
<td>For working voltage from 3.3 KV up to &amp; including 33 KV.</td>
</tr>
<tr>
<td>IS: 10810</td>
<td>Method of test for cables</td>
</tr>
<tr>
<td>IS: 1255</td>
<td>Code of practice for installation &amp; maintenance of power cables up to &amp; including 33 KV rating.</td>
</tr>
<tr>
<td>IS: 8130/IEC: 60228</td>
<td>Conductors for cables</td>
</tr>
<tr>
<td>IS: 10418</td>
<td>Drums for electric cables.</td>
</tr>
<tr>
<td>IS: 2062, IS: 800, IS: 816</td>
<td>Structural wedding steel</td>
</tr>
</tbody>
</table>

SUBMITTALS

Cable schedule as per site conditions & good for construction drawings.
Layout of various cables on cable tray / trench along with sections showing no. of cables, distance between cables etc, size of cable trays etc.

Cable tray layout, as per site condition, duly coordinated with other services.

TEST REPORTS
Routine test certificates for each drum of cable brought to site.

SPECIFICATIONS

GENERAL
Cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

MATERIAL
The MV power cable of 1100 V. grade shall be FRLS Aluminium conductor armoured cable as per relevant IS.

The MV control cables shall be PVC insulated copper conductor armoured cable.

The HT power cable of 33 KV grade shall be XLPE insulated Aluminium conductor armoured cable.

INSTALLATION

GENERAL
The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S. 1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

PROXIMITY TO COMMUNICATION CABLES
Power and communication cables shall as far as possible cross at right angles. Where power cables are laid in proximity to communication cables the horizontal and vertical clearances shall not normally be less than 30 cm.

CABLE LAYING DIRECT IN GROUND

GENERAL
This method shall be adopted where the cable route is through open country along roads/lanes etc. and where no frequent excavation are encountered and where excavation is easily possible without affecting other services.

TRENCHING

WIDTH OF TRENCH: - The width of trench shall be determined on the following basis:

a) The minimum width of trench for laying single cable shall be 35 cm.

b) Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified shall be at least 20 cm.
c) There shall be a clearance of at least 15 cm between axis of the end cables and the sides of the trench.

**DEPTH OF TRENCH**:- The depth of trench shall be determined on the following basis:

a) Where cables are laid in single tier formation, the total depth of trench shall not be less than 75 cm. for cables up to 1.1 KV and 1.20 m for cables above 33 KV.

b) When more than one tier of cables is unavoidable and vertical formation of laying is adopted, depth of trench in a (i) above shall be increased by 30 cm. for each additional tier to be formed.

**EXCAVATION OF TRENCHES**

a) The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided complying with the requirements.

b) Where gradients and changes in depth are unavoidable, these shall be gradual.

c) Excavation shall be done by any suitable means-manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.

d) Adequate precautions shall be taken not to damage any existing cables, pipes or other such installations in the proposed route during excavation. Wherever bricks, tiles or protective covers or bare cables are encountered, further excavation shall not be carried without the approval of the Engineer-in-Charge.

e) Existing property exposed during trenching shall be temporarily supported or propped adequately as directed by the Engineer in charge. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled.

f) If there is any danger of a trench collapsing and endangering adjacent structures, the sides should be well shored up with timbering and/or sheeting as the excavation proceeds. Where necessary, these may even be left in places when back filling the trench.

g) Excavation through lawns shall be done in consultation with the staff of the department/Owner concerned.

h) The bottom of the trench shall be level and free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm. in depth.

**LAYING OF CABLE IN TRENCH**

a) At the time of issue of cable for laying, the cores shall be tested for continuity and insulation resistance.

b) The cable drum shall be properly mounted on jacks or on a cable wheel, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

c) The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be pulled of in one stretch. However, where this is not possible the remainder of the cable may be removed by 'Flaking' i.e. by making one long loop in the reverse direction.
d) i) After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 m apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

ii) For short runs and sizes up to 50 Sq. mm of cables up to 1.1 KV grade, any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-Charge.

e) When the cable has been properly straightened, the cores shall be tested for continuity and insulation resistance. In case of PVC cables, suitable moisture seal tape shall be used for this purpose.

f) i) Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 17 cm above the base cushion of sand before the protective cover is laid.

ii) In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 30 cm shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cm as stated above. The top most cable shall have a final sand covering not less than 17 cm before the protective cover is laid.

g) At the time of original installation, approximately 3 m of surplus cable shall be left on each end of the cable and on each side of underground joints (Straight through/Tee/Termination) and at entries and places as may be decided by the Engineer-in-Charge. The surplus cable shall be left in the form of a loop. Where there are long runs of cable length loose cable may be left at suitable intervals as specified by the Engineer-in-Charge.

h) A final protection to cables shall be laid in accordance with Clause j to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.

i) Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20 cm x 10 cm x 10 cm (nominal size) as per CPWD Building Specification or protection covers placed on top of the sand, (bricks to be laid breadth wise) for the full length of the cable to the satisfaction of the Engineer-in-Charge. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5 cm over the sides of the end cables.

**BACK FILLING**

a) 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 30 cm. 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. The crown of earth however should not exceed 10 cm. so as not to be a hazard to vehicular traffic. The temporary re-instatements of roadways should be inspected at regular intervals, particularly during the wet weather, and any settlement should be made good. Further trenches cut through roadways or other paved areas shall be restored to the same density and material as the surrounding area and repaved in accordance with the relevant Specifications to the satisfaction of the Engineer-in-Charge.

a) Where road berm or lawns have been cut or kerb stones displaced, the same shall be repaired and made good except turfing/asphalting to the satisfaction of the Engineer-in-Charge and all surplus earth or rock removed to places as specified.

**ROUTE MARKERS:**
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

a) Route markers shall be provided along straight runs of the cables at locations approved by the Engineer-in-Charge and generally at intervals not exceeding 100 m. Markers shall also be provided to identify change in the direction of the cable route and also for location of every underground joint.

b) Route markers shall be made out of 100 mm x 100 mm x 5 mm GI/Aluminium plate, welded or bolted on to 35 mm x 35 mm x 6 mm angle iron 60 cm. long. Such plate markers shall be mounted parallel to and 0.5 m or so away from the edge of the trench.

Alternatively cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) marker 60 cm x 60 cm 10 cm in size shall be laid flat and centred over the cable. The concrete markers unless otherwise instructed by the Engineer-in-Charge shall project over the surrounding surface so as to make the cable route easily identifiable.

c) The work 'cable' and other details such as voltage grading, size etc. as furnished by the Engineer-in-Charge shall be inscribed on the marker.

LAYING IN PIPES/CLOSED DUCTS:

In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.

The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

All chases and passages necessary for laying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.
Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

**LAYING ON CABLE TRAY**

Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers, coupler plates, and structural steel members (comprising of channels, angles, flats, rods) for structural supports for cable trays etc.

**CABLE TRAY MOUNTING**

Unless otherwise specifically noted on the relevant layout drawing, all cable tray mounting works to be carried out ensuring the following:

a) Cable tray mounting arrangement type to be as marked on layout drawing.

b) Assembly of tray mounting structure shall be supplied, fabricated, erected & painted by the contractor.

c) Cable tray running along the wall should be supported at intervals not exceeding 1.5 m. In case of branching, there should be a support on all branches at a distance of 30 cm from the point of branching. Support should not be less than 40 mm x 40 mm x 5 mm MS angle-secured in an approved manner where runs are along the walls. In case of ceiling suspended cable tray horizontal supports made of 40 mm x 40 mm 5 mm MS angle iron shall be provided. The horizontal interval between two such supports shall be 1.0 meter. These supports shall be suspended from C.I. boxes or suitable approved suspension devices such as dash fastener of suitable sizes in the ceiling by means of 10 mm diameter GI threaded rods. All above mounting accessories form part of installation of cable trays.

**TESTING & COMMISSIONING**

**INSPECTION**

All cables shall be inspected upon receipt at site and checked by the Engineer-in-Charge for any damage during transit.

**TESTING**

i. All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/amour and insulation resistance between conductors.

ii. All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

**COMPLETION PLAN AND COMPLETION CERTIFICATE**

a) After completion of the work the Contractor shall draw completion plans to a suitable scale and shall submit to the Engineer-in-Charge. The completion plans shall, inter-alia, give the following details

i) Layout of cable work

ii) Length, size, type and grade of cables.

iii) Method of laying i.e. direct in ground, in pipes etc.
iv) Location of each joint with jointing method followed.

v) Route marker and joint maker with respect to permanent land marks available at site.

vi) Wherever the previously laid cable is cut and additional joints are introduced etc., the cable records shall suitably be amended.

TESTING OF CABLES

The cables shall be tested before and after laying. The Megger value in normal dry weather shall be 50 Mega ohm for 1.1 KV grade cable. This value shall be 100 Mega ohm for 11 KV grade cable.

CABLE TAGS

Cable tags shall be made out of 2mm thick aluminum sheets. Each tag shall be 2” in dia or 3” x 3” square with one hole of 2.5mm dia, 6 mm below the periphery, or as approved by Consultant. Cable designations are to be punched with letters / number punches and the tags are to be tied to cables with piano wires of approved quality & size. Tags shall be tied inside the panels beyond the glanding as well as above the glands at cable entries. Along trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 meters. Cables shall be secured to cable trays with 3mm thick x 25mm wide aluminium strips/suitable GI clamp, or as approved by Consultant, at 1000 mm intervals and screwed by means of rust proof screws and washers, of adequate but not excessive lengths. Cable trays for horizontal runs suspended from the ceiling will be supported with mild steel straps or brackets, at 1000 mm intervals and the overall tray arrangement shall be of a rigid construction. External cabling route marker with C.I. plate marked with “DANGER 1.1 KV CABLE” with 0.6 meter long GI angle iron grouting bracket including 1:3:6 ratio cement concrete base block of minimum size 200 x 200 x 350 mm to be provided or as approved by Elect. Supply Company.

CABLE TRAY

All cables trays shall be made of M.S. sheet.

Cable trays shall be complete with bends, joints, coupler plates and accessories as may be required for joining the cable trays. The bends, Tee joint, Cross joint for all sizes of cable tray shall be factory fabricated.

Cable trays shall be either perforated or ladder type as called for in the schedule of quantities.

PERFORATED CABLE TRAY

Standard dimensions of perforated cable trays shall be as follows:
1. Width     : 100 mm to 1200 mm
2. Length    : 2500 mm
3. Thickness : 1.6 mm up to 300 mm width and
               2 mm 450 mm to 600 mm width and
               3 mm from 901 mm to 1200 mm
4. Collar height : 50 mm up to 600 mm and 75 mm from 750 mm to 1200 mm

**LADDER TYPE CABLE TRAY**

Standard dimensions of ladder type cable trays shall be as follows:

<table>
<thead>
<tr>
<th>SIZE OF TRAY</th>
<th>SIZE OF MAIN CHANNEL</th>
<th>SIZE OF RUNG/SPACING BETWEEN RUNGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>900mm to 1200mm</td>
<td>25 x 100 x 25 x 3mm</td>
<td>20 x 50 x 20 x 2 @ 200C/C</td>
</tr>
<tr>
<td>Up to 750mm</td>
<td>25 x 75 x 25 x 2mm</td>
<td>20 x 50 x 20 x 2 @ 200C/C</td>
</tr>
</tbody>
</table>

Sizes of angle for cable tray supports shall be minimum 40 x 40 x 5 mm up to 600 mm & 50 x 50 x 5 mm minimum as specified in the drawings/schedule of quantities for sizes above 600 mm. Hangers shall be of minimum 10 mm dia steel round bars up to 600 mm & 12 mm dia steel from 750 mm to 1200 mm as specified in the drawings/schedule of quantities. All the support shall be G.I.

Fixing arrangement shall be as approved by the Consultant.

Hardware to be used in cable tray system shall be galvanized or zinc passivated.

The testing on galvanized material if required shall be carried out as per IS: 2633, amended to date.

**RACEWAY**

All raceway shall be of 1.6 mm/2.0 mm thick G.P. sheet as specified in BOQ. The raceway shall have Z-section, hole with thread for cover screw, coupler plate, cover, junction box, fly cover etc as required. The screw for cover fixing shall be counter sunk type. The size of raceway shall be as follow.

<table>
<thead>
<tr>
<th>WIDTH (mm)</th>
<th>HEIGHT (mm)</th>
<th>THICKNESS (mm)</th>
<th>COVER THICKNESS (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>40</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>75</td>
<td>40</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>150</td>
<td>40</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
SAFETY MATERIALS

DESCRIPTION OF WORK

A. Insulation Mats
B. First Aid charts and First Aid Box
C. Danger Plate
D. Fire Extinguishers
E. Fire Buckets
F. Tool Box
G. Caution Board
H. Key Board

APPLICABLE CODES & STANDARDS

A. IS : 15652 Insulation mats
B. IS : 2878 Portable C02 Fire Extinguisher
C. IS : 2546 : Fire Buckets

SUBMITTALS

A. Product Catalogues.

SPECIFICATION

INSULATION MATS

A. Insulation mats conforming to IS: 15652 shall be provided in front of main switch boards and other control equipment as specified.

FIRST AID CHART AND FIRST AID BOX

A. Charts (one in English, one in Hindi, one in Regional Language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate places. Standard First
Aid Boxes containing materials as prescribed by St. John Ambulance brigade or Indian Red Cross should be provided in sub-station.

DANGER PLATE

A. Danger plates shall be provided on HV and LV equipments. LV danger notice plate shall be 200 mm x 200 mm made of mild steel atleast 2 mm thick vitreous enamelled white on both sides and with inscriptions in signal red colour on front side as required.

B. Size of the HV Danger Notice plate shall be 250 mm x 200 mm and 2 mm thick.

FIRE EXTINGUISHERS

A. Portable CO₂ conforming to IS: 2878-1976 dry chemical (conforming to IS 2171-1976) extinguishers shall be installed in the sub-station at suitable places (like HT/LT panel rooms) as specified.

B. Foam type fire extinguisher shall be installed in Transformer Room.

FIRE BUCKETS

A. Fire buckets conforming to IS: 2546-1974 shall be installed with the suitable stand for storage of water and sand.

TOOL BOX

A. A standard tool box containing necessary tools required for operation and maintenance shall be provided in sub-station.

CAUTION BOARD

A. Necessary number of caution boards such as "Man on Line" "Don't switch on" etc. shall be available in the sub-station.

B. The Caution Board shall be of size 300 mm x 200mm made of mild steel, 2mm thick, vitreous enamelled white on both sides and with inscriptions in original red colour on front side as required.

KEY BOARD

A. A key board of required size shall be provided at a proper place containing castel keys, and all other keys of sub-station and allied areas.

B. The Key board shall be made of 12mm thick first class teak wood shall be of size 400 mm x 300m and with adequate depth to hold the keys. It shall be provided with a lockable type hinged glass door made of 12 mm. thick first class teakwood frame with 3 mm thick sheet glass fixed with piano hinges. The key board shall enough number of hooks for hanging the castle keys and all other keys of the sub-station and allied areas. It shall be painted with one coat of wood primer and two coats of white enamel paint.

PIPING WORK (D.G. FLUE GAS EXHAUST SYSTEM)

SCOPE OF WORK

The scope of this section comprises supply, installation, testing & commissioning of D.G. Flue Gas Exhaust System pipes & pipe fittings etc. as detailed below in specifications. All pipes and fittings etc. shall conform to relevant Indian standards.
D.G. FLUE GAS EXHAUST PIPING

D.G. Exhaust pipes shall be M.S. Black pipes up to 150 mm and MS ERW Black Pipes above 150 mm and it shall conform to IS:1239 (Part 1) -1991 & IS:3589 – 1991 Grade 330 with latest amendments.

All piping and their steel supports shall be thoroughly cleaned and primer coated before installation.

PIPE FITTINGS

The pipe fittings for screwed piping shall be malleable iron and for piping with welded joints shall of weldable quality. Also the fittings shall be suitable for same pressure ratings as for the piping system.

All bends up to sizes 150 mm dia shall be ready made of heavy duty wrought steel of appropriate class.

All bends in sizes 200 mm and above shall be fabricated from the same dia and thickness of pipe in at least four sections and having a center in radius of at least 1.5 times diameter of pipes. Fittings such as tees, reducers etc. shall be fabricated from the same pipe and its length shall be at least twice the diameter of the pipe.

The dead ends shall be formed with flanged joints & shall have 6mm thick blank between flange pair for 150 mm and over.

FLANGES

All flanges shall be of mild steel as per IS : 6392 / 71 (with latest amendments) & shall be slip on type welded to the pipes. Flanged thickness shall be to suit Class II pressure.

Flanged pair shall be used on all such equipments which are required to be isolated or removed for service.

PIPING INSTALLATION

The drawings attached with this tender indicate schematically the sizes, location of pipes & vertical shafts. The contractor, on award of the work, shall prepare detailed shop drawings based on tender drawings, showing the cross-section, longitudinal sections, details of fittings and all pipe supports.

Piping shall be properly supported on, or suspended from, stands, clamps, springs, hangers as specified and as required at site. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and shall be responsible for their structural sufficiency. A set of piping support calculations shall be submitted for structural engineer review and approval before site installation wherever critical & required.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint 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 Sizes</th>
<th>Spacing Between Supports</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 12 mm</td>
<td>1.2 Meter</td>
<td>8 mm</td>
</tr>
<tr>
<td>15 to 25 mm</td>
<td>1.8 Meter</td>
<td>8 mm</td>
</tr>
<tr>
<td>32 to 150 mm</td>
<td>2.4 Meter</td>
<td>10 mm</td>
</tr>
<tr>
<td>Above 150 mm</td>
<td>-----------As Per Approved Shop Drawing------</td>
<td></td>
</tr>
</tbody>
</table>
Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on all floors. 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.

T heading in exhaust piping shall be avoided.

Pipe sleeves at least 3 mm thick, 50 mm / 100 mm larger in diameter than exhaust pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fibre glass and finished with retainer rings welded on the ends of the sleeve. All pipes passing through the retaining wall shall be provided with suitable water proofing compound.

Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant.

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.

All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges beveled 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.

**PIPE INSULATION (D.G. FLUE GAS EXHAUST PIPING SYSTEM)**

**SCOPE OF WORK**

The scope of this section comprises supply, installation, testing & commissioning of D.G. Flue Gas Exhaust Pipe Insulation and Aluminium Cladding as detailed in BOQ. All insulation material and aluminium cladding shall conform to relevant Indian standards.

**H.T. METERING PANEL (INDOOR TYPE):**

**GENERAL**

H.T. Metering Panel shall be made as per regulation of Local Electricity Supply Authority.

**CODES AND STANDARDS**

- The 33 H.T. Metering Panel shall comply with the following standards as amended up to date.
  
  IS: 2544 : Bus Bar Supports
  
  IS: 2705 / IEC – 185 : Current Transformer
  
  IS: 3516 / IEC – 186 : Potential Transformer

**SUBMITTALS**

**SHOP DRAWING AND TECHNICAL DATA**
The Tenderer shall furnish relevant technical data on H.T. Metering Panel and associated equipment along with the offer.

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.

b) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.

c) All drawings and data shall be in English.

TYPE AND CONSTRUCTION

The metal clad panel shall be made out of 2.0 mm thick CRCA sheet steel. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphating process and shall then be given powder coating (Electrostatic) paint of manufacturer’s standard shade.

a. C.T. & P.T. Compartment
b. Energy Meter Compartment
c. Cable Termination Compartment

The compartments shall be dust & vermin proof and safe to touch. The H.T. Metering Panel shall be suitable for cable termination from bottom only. The Panel shall be supplied with all equipment mentioned in BOQ and as per regulation of Local Electricity Supply Authority.

33 KV VACUUM CIRCUIT BREAKER:

GENERAL

Vacuum Circuit Breaker shall be incorporated in H.T. Panel wherever specified. VCB’s shall be suitable for operation on 33KV, 3 phase, 50Hz, AC supply.

CODES AND STANDARDS

The 33 KV VCB Panel shall comply with the following standards as amended up to date.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 2516 (Part I – Set 3)</td>
<td>Indian Electricity Supply and regulations.</td>
</tr>
<tr>
<td>IEC 60298 &amp; IEC 60694</td>
<td></td>
</tr>
<tr>
<td>IS : 3427 &amp; IS 12729</td>
<td>Vacuum Circuit Breakers</td>
</tr>
<tr>
<td>IEC : 529</td>
<td>Degree of Protection – IP 55</td>
</tr>
<tr>
<td>IS : 2544</td>
<td>Bus Bar Supports</td>
</tr>
<tr>
<td>IS : 2705 / IEC – 185</td>
<td>Current Transformer</td>
</tr>
<tr>
<td>IS : 3516 / IEC – 186</td>
<td>Potential Transformer</td>
</tr>
</tbody>
</table>
RATING

The rating of the vacuum circuit breaker shall be as per the drawings and schedule of quantities. The rated/breaking capacity of the breaker shall be 1000 MVA (18 KA RMS) at 33 KV. The rated making capacity shall be as per the relevant standards.

ACCESSORIES

Circuit Breakers shall be provided with the following accessories.

i. Auxiliary Switch with minimum 6 NO+ 6 NC auxiliary contacts.

ii. Shunt Trip Coil

iii. Mechanical Operation Counter

iv. Spring Charging motor and handle for manual charging

SUBMITTALS

SHOP DRAWING AND TECHNICAL DATA

The tenderer shall furnish relevant technical data on breakers and associated equipment along with the offer.

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.

b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.

c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.

d) Type test certificates along with oscillograms for breakers of identical design.

e) All drawings and data shall be in English.

TYPE AND CONSTRUCTION

The metal clad panel shall be made out of CRCA sheet steel. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphating process and shall then be given powder coating (Electrostatic) paint of manufacturer’s standard shade. The Switch Board Shall be fully extensible with following compartment.

a. Circuit Breaker Compartment

b. Bus bar Compartment
c. CT and Cable Termination Compartment

The compartments shall be dust & vermin proof and safe to touch. A separate metering chamber for fixing the necessary instrumentation metering and protective equipment shall be mounted on the top / bottom of the panel at the front. The VCB shall consist of three air insulated poles incorporating mechanism of interrupters and suitable clearance between phases. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalized aluminium oxide. The contacts shall be of chromium copper and butt shaped. Vacuum circuit breaker shall be mounted on truck or a carriage mechanism. The drawout carriage shall have two position for the circuit breaker viz isolated/test & service position. Bus bars shall be insulated type made of high conductivity copper supported on cast epoxy mono block designed to withstand full short circuit currents and shall be provided all along the length of the H.T. board.

It shall be horizontal draw out & isolation type, fully interlocked, with dust and vermin proof construction, suitable for indoor installation. The panel shall be supplied with the manufacturer’s test certificates. Certificates with date of manufacture and shall be complete in all respects as per details given in the bill of quantities. The switchgear constructions shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0mm thickness. It shall have a rigid, smooth, leveled, flawless finish.

Total height of the H.T. Panel board shall be 2750mm approximately and width 1200mm (approx.). On the incoming breaker panel, a 100VA burden and Class I accuracy potential transformer 33KV/√3 /110V/√3 with LT fuses shall be provided. These shall be three single phase PTs cast resin insulated type. Adequate space at the rear of the panel shall be provided for termination of power & control cables. The panel shall be provided with suitable terminating arrangement for termination of cables. The making contact arms (upper & lower) of the circuit breaker shall be encased in polypropylene tubes. Penetration type bushings shall be provided in the bus bars & cable compartment for the fixed contacts. Safety shutters shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the draw out carriage. It shall, however, be possible to open the shutters of bus bars side and cable side individually.

Mechanically operated circuit breaker auxiliary switches of minimum 6 NO + 6 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by using 1.5 sq. mm, 1.1KV grade stranded copper PVC insulated cable. All control fuses shall be HRC link type.

L.T. Terminal blocks for control wiring shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The L.T. control circuit shall be routine tested to withstand 2.0KV for one minute. Bus bar compartment shall be provided at the rear. Electrolytic copper bus bars shall be of rectangular cross section and insulated. Bus bars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Bus bars shall be provided with necessary colour coding for phases indication. The bus bars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 50 deg. C. The standard clearance between phase bus bars to be maintained.

**BUS BAR AND INSULATORS**

Bus bars and connections shall be of high conductivity electrolytic copper conforming to relevant IS standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Bus bar cross section shall be uniform throughout the length
of switch board. Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance. Bus bar insulators shall be of track-resistance, high strength, non-hygrosopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Bus bar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the bus bars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

EARTHING AND PROTECTIVE EARTHING

Copper earthing bus shall be provided. It shall be bolted/ welded to the frame work of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting Owner’s earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of bus bars & feeder circuit.

METERING AND PROTECTION

The VCB Panel Board shall be provided with cast resin current transformers for metering and protection. The CT’s shall conform in all respects to IS 2705-1964 Part-I, II and III. These shall have accuracy class of 1.0 for metering of 5P10 for protection. Potential transformers shall be epoxy cast resin type & conform to specifications of IS: 3156-1965 Part-I, II & III and shall be class-1. Electronic digital type Ammeter and voltmeter to be installed on panel. Electronic type digital energy analyser having parameter of KW, KWH power factor, frequency etc. with 30 days memory shall be provided. All meters shall be tested for 2000V for 1 minute and shall be 96mm square pattern, flush mounting type with necessary selector switches. Necessary indicating lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5W), The electronic digital types IDMT relay (2 O/C + 1 E/F) to be provided as per B.O.Q. description.

INTERLOCKING, SAFETY AND OPERATING MECHANISM

Vacuum Circuit Breaker shall have electrically operated mechanism for spring charging. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty. The drawout carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is ‘On’. The circuit breaker cannot be switched ‘ON’ when the carriage is in any position between test & service position. The front door of the panel cannot be opened when the breaker is in service position or in an intermediate position. The low voltage plug & socket cannot be disconnected in any position except test/isolated position. The door cannot be closed unless the LV plug has been fitted. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed. Individual explosion vents shall be provided for breaker, bus bar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel. Circuit Breaker & sheet metal enclosure shall be fully earthed. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the drawout carriage mechanism.

ADDITIONAL ACCESSORIES

The loose items to be supplied with the 33KV VCB Panel Board shall comprise of the following:
b. Racking in/out handle.
c. Foundation bolts.
d. One number Earthing Trolley for cable side.

CONTROL SUPPLY

a. The tripping circuit shall be at 24 Volt D.C. through a power pack unit.

INSTALLATION

a. 33 KV switch board shall be installed and levelled on the foundation as per manufacturer's drawing. Bus bar connections shall be checked after installation. Cable end boxes shall be sealed after the cable work is completed to prevent absorption of moisture.

TESTS

FACTORY TESTS

The circuit breakers panel shall be subjected to routine tests at manufacturers works in accordance with the details specified in the relevant IS specifications.

The vendor shall submit the type test certificate for following along with the offer.

a. Temperature rise test.
b.Impulse & power frequency voltage test
c. Short time current test on circuit breaker.

SITE TEST

GENERAL

1. Verification for completion of equipment, physical damage/ deformities.
2. Alignment of panel, interconnection of bus bars & tightness of bolts & connection etc.
3. Interconnection of panel earth bus bar with plant earthing grid.
4. Inter panel wiring between transport sections.
5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.
6. Control wiring verification after interconnecting of panel.
7. Check for free movement of circuit breaker, lubrication of moving part & other Parts as per manufacturers manual.
9. Meggar before the Hi Pot test.
10. Meggar after the Hi Pot test.
11. CT/PT ratio/polarity primary injection test.

12. Secondary injection test on relays to practical characteristics.

These tests as per the clauses above will be witnessed by the owner/consultant at the works for which necessary information has to be given in advance to the owner/consultant.

33KV/0.415KV DISTRIBUTION TRANSFORMER -

**GENERAL**
The transformer shall comply with the latest edition of the relevant Indian Standards / Manual. The transformer shall be copper double wound core type, oil natural air natural cooled suitable for indoor installation. The transformer shall be designed and manufactured as per IS – 2026 & 9815 with up to date amendments. Transformer shall be suitable for continuous rating as stated in BOQ and on drawings. The transformer winding shall be of electrolytic copper conductors covered with a special material having high tensile and dielectric strength. The Core shall be made up of high grade low loss cold rolled grain oriented steel sheets (CRGO). Core shall be treated with high temperature resistant paint to prevent corrosion at edges of the core plates. Distribution Transformer with on load tap changer, Balanced supply and unbalanced load.

**INPUT** : 33 KV, 3 Phase, 3Wire, 50 Hz.

**OUTPUT** : 0.415 KV, 3 Phase, 4 Wire, 50 Hz.

**RATING** : 1750 KVA

**VECTOR GROUP** : Dyn-11

**OLTC** : +5.0% TO -15.0% IN STEP OF 1.25%

**AMBIENT TEMP** : -5 TO + 50 degree centigrade

**OIL TEMP RISE** : 40 deg. C. over a maximum ambient of 50 deg. C.

**WINDING TEMP RISE** : 50 deg. C. over a maximum ambient of 50 deg. C.

**WINDING TEMP** : Winding temp. indicator with NO/NC contact to be provided.

**OIL TEMP** : Oil temp. indicator with NO/NC contact to be provided.

**BUCHOLZ RELAY** : Buchholz Relay with NO/NC contact to be provided.

**IMPEDANCE** : 6.25%

**LOAD LOSSES** : AS per ECBC 2007 (Revised)

**TANKS & RADIATORS**
Tanks shall be of MS. plates and structures, electrically welded. The construction shall be robust and substantial, suitable for road/rail transport and to withstand vibration. Radiator tubes shall be electrical resistance welded type, round or elliptical or rectangular. They may be welded to the transformer tank or in case of very large sizes to separate detachable radiator banks connected through intermediate leak proof...
valves. Detachable radiator banks shall have top and bottom headers with flanged connections, with drain and vent fittings. Tanks shall be provided with lifting lugs and jacking lugs. Inspection hole with cover should also be provided for large transformers. Oil conservators shall be mounted on brackets attached to the top cover on tank. Dimensions of the conservator shall be such as to allow change in volume of oil due to change in temperature from 0°C to 100°C.

Tanks shall be thoroughly cleaned, degreased and sand blasted inside and outside. A coat of rust resisting primer shall immediately be given on outside surface. Inside surface shall be painted with oil resistance enamel paint. Tank and radiators shall be hydraulically pressure tested. Tanks shall also be tested for full vacuum.

**CORES**

Cores shall be built from cold rolled grain oriented silicone steel laminations. The core laminations shall be insulated from each other by suitable high temperature resistant, oil proof, adherent coating materials. Core clamps and clamping bolts shall be heavily insulated from the core laminations.

The insulations of core bolt shall be minimum of class ‘A’. The bottom and top frames shall be connected with the tie rods to make a complete structure rigid for carrying the weight of core-coil assembly without unduly stressing the laminations or windings. Lifting eyes shall be provided on the frame for removal of core assembly from the tank. Completed core shall be flash tested for insulation with 2500 Volts between the core and each of the clamps or core bolts (core being connected to earth).

All the core frames shall be bonded together with two metallic strips and connected to the tank for earthing to ensure earth return and operation of protective gear in the event of a fault. Lifting eyes (or any other provision) for lifting the core from the tank shall be provided.

**WINDING & INSULATION**

Winding shall be three phase with minimum class ‘A’ insulation. High conductivity electrolytic quality copper shall be used for winding. Windings shall be suitably braced to withstand the dynamic forces due to short circuit. Winding insulation shall be uniform and windings shall have full insulation. Windings shall be individually vacuum dried before assembly as well as after assembly.

**INSULATION OIL**

Insulation oil shall conform to IS: 335. Transformers shall be supplied with initial fill of filtered oil.

**GENERAL REQUIREMENTS**

The transformer shall be outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short circuit as per Clause 9 of IS: 2026 (Part I) 1977.

**COOLING**

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

**RTCC PANEL**

RTCC Panel shall be microprocessor based Integrated RTCC Panel and shall be suitable for outdoor installation.

**ACCESSORIES**
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

The transformer shall be single tank type with 33 KV HV cable box as specified on HV side. LT side shall be suitable to receive the Bus Duct.

EXPLOSION VENT

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and gas accumulation.

RATING AND DIAGRAM PLATES

The following plates shall be fixed to transformer tank in a visible position.

a. A rating plate of weather proof material bearing the data specified in the appropriate clauses IS: 2026.

b. A diagram plate showing the internal connections and also the voltage vector relationship of the several windings in accordance with IS: 2026 and a plan view of the transformer giving the correct physical relationship of the terminals.

JOINTS AND GASKETS

All gaskets used for making tight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber.

TESTS

The transformer shall be subjected to the following routine tests at the manufacturer's works before dispatch.

a) Measurement of winding resistance.

b) Voltage ratio, polarity and phase relationship.

c) Measurement of impedance voltage.

d) Load losses.

e) No load losses and no load current.

f) Induced over voltage withstand.

g) Separate source voltage withstands.

i) Vector group.

j) DV/DF Test.

k) Magnetic Balance Test.

l) High Voltage Test.

m) Insulation Resistance Test

n) All other test as specified in relevant IS Code.

The quoted rate for the transformer shall include all routine tests to be carried out at the manufacturer's works and all routine tests to be carried out at site as per specifications. The contractor shall quote separately for type tests, which shall be carried out only on the written instructions of Owner. The supplier shall give sufficient advance information about the test schedule to enable the owner to appoint his representative.
TESTING AT SITE

Prior to commissioning of the transformer the following tests shall be performed.

a) Insulation resistance of the winding between phases and earth of H.V and M.V. Side.
b) Voltage ratio test at principal tap, minimum tap & maximum tap position.
c) Magnetic Balance Test.
d) Performance/Settings of winding Temperature Indicator, Oil Temperature Indicator.

a) Insulation Resistance Test

CONTROL SUPPLY (SHALL BE PART OF H.T. PANEL)

a. The tripping circuit shall be at 24 Volt D.C. through a power pack unit.

MAIN L.T. PANEL -

GENERAL

This section covers the detail requirements for Design, Manufacturing, Testing at works. Main L.T. Panel shall be made out of CRCA sheet steel indoor type, floor mounted, free standing, totally enclosed, extensible type, air insulated type for use on 415 Volts, 3 phase with neutral, 50 cycles/sec system. D.G. Panel shall have PLC and required Hardware and Software (as per the BOQ) to achieve the AMF, Synchronizing and Interlocking.

The equipment shall be designed to conform to the requirements of:

i. IS: 8623- Factory Built Assemblies of switchgear and control gear.
ii. IS: 4237- General requirements for switchgear and control gear for voltages not exceeding 1000 volts.
iii. IS: 2147- Degree of protection.
iv. IS: 375- Marking and arrangement of bus bar.

Individual equipment housed in the Main L.T. Panels shall conform to the following IS Specification.

i. Air circuit breakers/ moulded case circuit breaker IS: 60947 (Part-II) & IEC 60947(2)
ii. Fuse switch and switch fuse units - IS: 13947 (Part-3) & IEC 947 (3).
iii. HRC fuse links - IS: 13703
v. Current Transformers - IS :2705

Voltage Transformers - IS :3156
vi. Indicating Instruments - IS: 1248
vii. Integrating Instruments - IS : 722
viii. Control Switches & Push Buttons - IS: 6875
ix. Auxiliary Contactors - IS: 13947 (Part-4/Sec.-I) & IEC 947 (4/1)
x. Relays - IS: 3231

SUBMITTALS, SHOP DRAWING AND TECHNICAL DATA

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.

b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.

c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.

b) Type test certificates.

CONSTRUCTION

D. G. Panel shall be

1. Made out of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

2. The degree of protection being not less than IP 52 to IS: 2147.

3. Suitable for extensible on both sides by the addition of vertical sections after removal of the end covers.

4. Shall be suitable for cable entry from top / bottom both except wherever indicated through removable cable gland plate of 3 mm thick. Compression gland shall be staggered in alleys so as to maintain necessary clearance between cables.

5. Fire retardant polycarbonate sheet shall be provided for viewing panels housing MCB’s at eye level. Cable channels are to be used wherever possible for aesthetic look.

Lifting hooks / angles to be provided on the panel. Panel shall have 20% free space for future use.

Panel shall be provided with louvers having wire mesh inside for ventilation.

Each vertical section shall comprise of:

i. A minimum 2 mm thickness front framed structure of rolled/folded sheet steel channel section rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3 mm thickness and 100 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
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ii. Cable chamber housing (in rear of panel) the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

iii. Front and rear doors fitted with dust including neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. All door shall be lockable mounted lock.

The height of the panels should not be more than 2400 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be more than 1500mm. Operating handle not higher than 1800mm. The minimum height for operating handle shall be 300 mm from floor level.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 2mm thickness. All sheet panels shall be smoothly finished, levelled and free from flaws. The corners should be rounded.

The apparatus and circuits in the power control centres shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main L.T. Panel shall have the following minimum clearances.

i. Between phases - 32mm
ii. Between phases and neutral - 26mm
iii. Between phases and earth - 26mm
iv. Between neutral and earth - 26mm

For any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions. Creepage distances shall comply to those specified in relevant standards. All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Circuit breakers and fuse switches shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

i. Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

METAL TREATMENT AND FINISH
All steel work used in the construction of the L.T. cubicle panels should have undergone a rigorous metal treatment process as follows:

i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

v. Drying with compressed air in a dust free atmosphere.


**BUS BAR**

The bus bars shall be made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-9IE of IS-5082 and air insulated. The bus bars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105KA. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creepage distances shall be provided on the bus bar system to minimize possibilities of fault.

The Panel shall be designed that the cables are not directly terminated on the terminals of breaker/switch fuse/fuse switch etc. but on cable termination links. Capacity of aluminium bus bars shall be considered as 0.8 Amp/sq.mm of cross section area of the bus bar. The main bus bars shall have continuous current rating throughout the length of L.T. Panel. The cross section of neutral bus bars shall be same as that of phase bus bar for bus bars of capacity up to 200Amp; for higher capacity the neutral bus bar shall not be less than half (50%) the cross section of that the phase bus bars. The bus bar system shall consists of main horizontal bus bar and auxiliary vertical bus bars run in bus bar alley/chamber on either side in which the circuit could be arranged/connected with front access. The minimum size of vertical bus bar shall be as per fault level of panel i.e 50 KA.

In case of copper bus bars, high conductivity electrolytic grade copper with current density not less than 1.4 Amp/sq. mm shall be used. Bus Bar shall be tinned.

Connections from the main bus bars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars to be colour coded with PVC sleeves.

Cadmium plated G.I. nuts and bolts shall be used for making bus bar to bus bar connections in aluminium bus bars.

Whenever copper bus bar and aluminium bus bar are connected to each other, bimetallic strip shall be used. In case of copper bus bar, tinning shall be done.

Bus bar calculation shall be submitted along with manufacturing drawing of panel for approval with bus bar manufacturer data sheet.

**MEDIUM VOLTAGE AIR CIRCUIT BREAKER**
TYPE AND CONSTRUCTION

The ACB shall conform to the requirements of IEC 60947-2 / IS 60947-2 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 free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" “TRIP” indications.

Air circuit breakers shall have a rated operational voltage of 415V AC (50Hz) & impulse voltage of 12 kV.

The construction of circuit breakers shall be as per pollution degree 4 requirements to sustain harsh environments

The tests shall be carried out with a breaking performance during operation (Ics) and admissible short time withstand (Icw) equal to the ultimate breaking capacity (Icu). i.e. Icu = Ics = Icw = 50KA for 1 Sec.

The Circuit Breaker shall have minimum mechanical life of 10000 operations without maintenance.

The breakers shall deliver an electrical life of 6000 operations up to 2000A & 5000 operations for ratings 2500A and above under rated voltage of 440V AC, without maintenance.

All 4 Pole ACBs shall have fully rated neutral equal to rating of the breaker & shall be protected against over-load & short-circuit with provisions for settings at:

> 4P 3d - neutral unprotected,
> 4P 3d + N/2 - neutral protection at 0.5In,
> 4P 4d - neutral protection at In to ensure precise neutral protection.

Shunt trip and closing coil shall be of continuous rated design and both should be accessible from the front of ACB after opening the cover, without disturbing any other part/release.

The Circuit Breaker shall have minimum 4 changeover auxiliary contacts rated at 10 A 240/380V volts 50 Hz. There should exist, facility to add one more set of 4 contacts as required.

Ready-to-close contact shall exist for indicating that all safety parameters are checked & enabling closure of breaker, ensuring at-most safety for the user.

The withdrawable circuit breaker shall have the following three distinct and separate positions, which shall be indicated on the face of the panel.

> "Service" -- Both main and auxiliary circuits are connected.
> "Test" – All auxiliary circuits are connected & main circuits are disconnected.
> "Isolated" -- Both main and auxiliary circuits are disconnected.

There should be a positive locking at these positions while racking out or racking in for clear & confirmative indications as the position is reached. A release push button shall be available to release the lock.

A door interlock shall be provided so that it shall not be possible to open the door until the air circuit breaker moving part is in the disconnected position.

The racking handle shall be stored on the air circuit breaker in such a manner as to be accessible without defeating the door interlocking.

The Circuit breaker protection shall be through intelligent ET range of electronic trip system suitable to protect the distribution network, against LI (Over load, Instantaneous), LSI (Overload, Short-Circuit & Instantaneous) & LSIG (Overload, Short-Circuit, Instantaneous & Ground fault).
The circuit breaker control unit shall be with display. The trip units with display shall be suitable to measure current and voltage parameters.

Control unit shall have fault history data & store last 10 trip causes.

The trip unit shall have following protection settings, based on the type of trip unit.

› Adjustable over load current (Ir) settings from 40% to 100% of rating of ACB (In).
› Over load time setting (tr) from 0.5s, 1s, 2s, 4s…….24s as field selectable curves
› Short circuit setting (Isd) from 1.5 to 10 times of Ir setting
› Short circuit time delay adjustable from 0 to 400 msec.
› Instantaneous (Ii) protection with an adjustable pick-up and an OFF position.
› Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400 ms.

PROTECTION

The protection release shall have following features and settings:

(i) **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.

(ii) **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.

(iii) **DEFINED TIME – CURRENT CHARACTERISTIC**
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.

(iv) **TRIP INDICATION**
Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

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.
Testing of each circuit breaker shall be carried out at the works as per relevant IS Code of Practice and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

i. Impulse withstand test.

ii. Power frequency withstand test.

iii. Short circuit test.

iv. Temperature - rise test under rated conditions.

**MOULDED CASE CIRCUIT BREAKER**

**GENERAL**

Moulded Case Circuit Breakers shall be incorporated in sub distribution boards wherever specified. MCCB’s shall conform to IS 13947-2 and / or IEC 947-2 in all respects. MCCB’s shall be suitable either for single phase AC 230 volts or three phase 415 volts. All MCCB shall be provided with rotary operating mechanism.

All MCCBs shall be suitable for 3 Phase 415 Volts AC 50 HZ supply.

All MCCBs shall have rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at defined operational voltage.

All MCCBs shall clearly indicate the suitability for isolation in the name plate identified by the symbol \[\text{\texttrademark}\].

All MCCBs shall offer class –II front face i.e. main current path of the circuit breaker should be isolated from auxiliary section

All MCCBs shall have cross bolted termination.

All MCCBs up to 250A shall have following features

- Single frame size with common accessories to reduce inventory
- Thermal magnetic trip unit
- Adjustable overload settings – 0.7-1 In
- Fixed short circuit settings
- Fully rated neutral for 4P MCCB
- 10000 electrical operations
- ON/OFF/Trip/Push to trip indication contacts

All MCCBs above 250A shall have the following features

- Single frame size with common accessories to reduce inventory
- Microprocessor trip unit
- Adjustable overload settings – 0.5-1 In
- Adjustable Short circuit – 2-10 lr
- Adjustable neutral for 4P MCCB – 0-0.5lr-1lr
- Thermal memory
- Test connector to check the healthiness of trip unit
- 4000 electrical operations
- ON/OFF/Trip/Push to trip indication contacts
Individual fault trip LED indications shall be available on all types of trip units for easy & faster identifying the cause of fault.

I’t ON / I’t OFF options shall be available for short-circuit & earth fault protections to enhance discrimination with downstream devices.

The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration.

The release shall be self diagnostic type with clear LED indication in case of mal functioning.

It shall be possible to change the protection settings on line and the circuit breaker need not be switched off while adjusting the setting.

Circuit breakers shall conform to Electromagnetic compatibility tests (EMC) as specified in IEC 60947-2, Appendix F.

Manufacturer shall submit the test certificates for the same.

The control unit shall have thermal memory throughout the range to store temperature rise data in case of repetitive overload or earth fault for protecting the cables and loads.

RUPTURING CAPACITY

The Moulded Case Circuit Breaker shall have a minimum fault breaking capacity (Ics) of not less than 50KA RMS at 415 volts or as specified in BOQ./ Drawing.

TESTING

Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished. Pre-commissioning tests on the sub distribution boards incorporating the MCCB shall be done as per standard.

MEASURING INSTRUMENT FOR METERING

GENERAL

The specifications herein-after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the bill of quantities.

DIGITAL AMMETERS

Digital Ammeters shall be confirm to IS: 13875. It shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition.

DIGITAL VOLTMETERS

Digital Voltmeters shall be confirm to IS: 13875. It shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition. The voltmeter shall be provided with protection MCB of suitable capacity.

CURRENT TRANSFORMERS
Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1KV. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 15A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

- Measuring: Class 1.0
- Protection: Class 5 P10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformer shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

**CONTROL SWITCHES**

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

**CABLE TERMINATION**

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminum conductor power cable and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be brass compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

**CONTROL WIRING**

All control wirings shall be carried out with 1100V grade single core PVC cable conforming to IS 694/IS 8130 having stranded copper conductors of minimum 1.5 sq. mm for potential circuits and 2.5 sq. mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

**TERMINAL BLOCK**
Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

LABELS

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

MISCELLANEOUS

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

BATTERY AND BATTERY CHARGER

A set of 24V DC power supply shall be provided for indication, relay operation etc. for Main L.T. Panel. DC Power supply shall be sealed maintenance free batteries of suitable capacity. Suitable battery chargers shall also be provided to charge the battery to perform during mains failure.

CAPACITOR BANK PANEL

Medium Voltage Capacitors and Control Panel to be used for improvement of power factor of the electrical system and shall be connected to Main L.T. Panels through L.T. Cable / L.T. Bus ducts. Automatic Power Factor Correction Panel shall function to improve power factor of the system in which it is connected. It shall improve power factor up to 0.99 from existing value.

CODES AND STANDARDS

Unless otherwise specified the capacitor and control panel shall conform to following.

a. IS: 2834 - Shunt capacitors for power systems.
b. IS: 2147 - Degree of protection provided by enclosures for low voltage switchgear and control gear.
c. IS: 4237 - General requirements for switchgear and controlgear for voltages not exceeding 1000V.
d. IS: 8623 - Specification for factory built assemblies of switchgear and control gear (Up to 1000 volts).
e. IS: 2208 - HRC cartridge fuse links up to 650 volts.
f. IS: 4064 - Specification for Fuse Switch & Switch Fuse switchgear and control gear.
g. IS: 2959 - AC contactors for voltage not exceeding 1000 volts.

SUBMITTALS

SHOP DRAWING AND TECHNICAL DATA

Complete technical data sheet including guarantee details giving the temperature rise, capacitor losses etc, Capacitor panel GA drawing, indicating mounting of capacitor units shall be furnished with the shop drawing.
SPECIFICATION

CAPACITORS

i. The capacitor shall be 3 phase heavy duty box type capacitor 525 Volt, 50 Hz, with 14% detuned reactor.

ii. The temperature rise above the specified ambient (50ºC) of any part of the capacitor and polyurethane resins associated equipment shall not exceed the permissible temperature as per IS: 2834.

iii. 50/25/10/5 KVAR capacitor units shall be used to form a bank of capacitors of desired capacity. All these units shall be connected in a parallel by means of solid bus bars of adequate current carrying capacity. The combination of capacitor unit shall be such as not to exceed permissible over voltage across the healthy capacitor units in case of failure of one or more units. Capacitor banks shall be suitable for operation at 110% of rated RMS voltage and 150% of rates RMS current. Each unit shall satisfactorily operate at 135% of rated KVAR.

iv. Construction-

The Capacitor banks shall be floor mounting type using minimum floor space. The container of capacitors shall be hermetically sealed in sturdy containers made out of 2 mm thick M.S. sheet steel. Dry type or synthetic non-inflammable oil shall be used for insulation. Each standard unit shall be provided with a built in silvered fuse.

v. Discharge Resistance

Each capacitor unit shall be individually protected by MCCB with indication to show when it is in operation. The capacitors shall be provided with permanently connected discharge resistors so that residual voltage of the capacitors shall be reduced to 50 Volts or less within one minute after the capacitor is disconnected from the sources of supply.

vi. Earthing

Two separate earthing terminals shall be provided for earth connection for each bank. All components and frame shall be properly earthed.

CONTROL PANEL

The panel shall be provided with necessary MCCB's, contactors, automatic required steps relays with associated CT's and power factor meter, indicating lamps, push buttons etc. Capacitors shall also be housed in the same panel. The panel shall be free standing type, dead front cubicle and shall be constructed from 2 mm thick sheet steel. The degree of protection shall be IP 54. This panel shall be integrated with the main L.T. panel unless specified otherwise.

PAINTING

As the capacitor panel is integrated with Main LT panel, it shall be painted as per specification in relevant Clause above.

SUB DISTRIBUTION PANEL
GENERAL

Sub Distribution Board shall be metal clad totally enclosed, rigid, floor mounting, air insulated, cubicle type for use on 415 volts, 3 phase, 50 cycle system. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

STANDARDS

The equipment shall be designed to conform to the requirements of:

IS 8623 – Factory Built Assemblies of switchgear and control gear.

IS 4237 – General requirements for switchgear and control gear for voltages not exceeding 1000 volts.

IS 2147 – Degrees of protection provided by enclosures for low voltage switchgear and control gear.

IS 375 – Marking and arrangement of bus bars.

Individual equipment housed in the sub distribution boards shall conform to the following IS specifications:

b) Miniature Circuit Breaker - IEC - 60898
c) Contractors - IEC – 947-4-1, IS 13947-4-1
d) Current Transformers - IS: 2705
e) Indicating Instruments (Analogue) - IS: 1248,
f) Indicating Instruments (Digital) - IS: 13875
g) Integrating Instruments (Analogue) - IS: 722, IS: 13779-1999
h) Integrating Instruments (Digital) - IS: 13779- 1999, IS: 14697
i) HRC fuse links - IS: 13703 / IEC 269

SUBMITTALS

Shop Drawings And Technical Data-

The tenderer shall furnish relevant technical data of switchgears and associated equipment along with the offer.

The Contractor shall furnish relevant descriptive and illustrative literature on switchgears and associated equipment and the following for approval before manufacture of the panel.

a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering compartment and terminal blocks for external wiring connections.

b) Typical and recommended schematic diagrams and control wiring.

c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
CONSTRUCTIONS

Sub Distribution boards shall be metal enclosed, indoor, floor mounted free standing and/or wall mounted type made up of the required vertical section, which when coupled together shall form continuous dead front. Sub distribution boards shall be dust and damp protected, the degree of protection being no less than IP: 54 to IS:2147. Sub distribution boards shall be fabricated with a framed structure with rolled/folded sheet steel channel section of Sheet steel shroud and partitions shall be of minimum 2mm thickness, doors and covers shall also be of 2mm thickness. All panel doors shall be pad lockable type. All sheet steel work forming the exterior of sub distribution boards shall be smoothly finished, leveled and free from flaws. The corners to be rounded. Front and rear doors to be fitted with dust proof including neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearance to be maintained after taking into account connecting bolts, clamps etc.

i) Between Phases - 32mm
ii) Between Phases and neutral - 26mm
iii) Between Phases and earth - 26mm
iv) Between Neutral & earth - 26mm

All insulating, materials used in the construction of the equipment shall be of non hygroscopic materials, duly treated to withstand the effect of high humidity, high temperatures, tropical ambient service conditions. SMC (Sheet Moulded Compound) supports & shrouds shall be used.

Functional units such as moulded case circuit breakers shall be arranged in multi-tier formation. The design of the sub distribution boards shall be such that each MCCB unit shall be fully compartmentalized.

Insulated barriers shall be provided with vertical section and between adjacent section to ensure prevention of accidental contact with main bus bars and vertical risers during operation, inspection or maintenance of functional units. All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fastness to prevent unauthorized access. Sub distribution boards shall be so constructed that the cable alley shall be sufficient enough to accommodate all the outgoing and incoming cables.

For each cable alley, there shall be separate cable gland plate of detachable type at the bottom and/or top of the panel as required. Gland plate shall be 3 mm thick.

A base frame made out of 75mm x 40mm x 5.0mm M.S. Channel to be provided.

METAL TREATMENT AND FINISH

All metal work used in the construction of the sub distribution boards should have undergone a rigorous metal treatment process as follows:

a) Effective cleaning by hot non alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution

b) Picking in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
c) A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to
prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be
followed by hot water rinsing to remove traces of phosphate solution.

d) Passivating in de-oxalite solution to retain and augment the effects of phosphating.

e) Drying with compressed air in a dust free atmosphere.

f) A finishing coat of powder coating of Siemens grey colour and thickness of powder coating shall not be less than
50 micron.

**BUS BARS**

The bus bars shall be air insulated and made of high conductivity, high strength Aluminium complying with the
requirement of grade E-91E.

The bus bars shall be suitably braced with non-hygroscopic SMC supports to provide a through fault withstand
capacity of 35KA RMS symmetrical for one second or as specified in BOQ/Drawing and a peak short circuit with
stand capacity of 105 KA.

The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on
the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creepage distance shall be
provided on the bus bar system to minimize the possibility of fault. The main phase bus bars shall have continues
current rating throughout the length of the panel. The cross section of neutral bus bars shall be same as that of the
phase bus bar for bus bars of capacity up to 250 Amp; for higher capacities, the neutral bus bar shall not be less than
half (50%) the cross section of that of the phase bus bars. Connections from the main bus bars to functional circuits
shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses
due to short circuit currents. Bus bars shall be colour coded with PVC heat shrinkable sleeves.

The sub distribution boards shall be designed that the cables are not directly terminated on the terminals of MCCB
etc. but are terminated on cable termination links. Capacity of aluminium bus bars shall be considered as 0.8 Amp
per sq. mm of cross section area of the bus bars.

**MEASURING INSTRUMENTS, FOR METERING:**

**GENERAL**

Direct reading electrical instruments shall be in conform to IS 1248. The accuracy of direct reading shall be
1.0 for voltmeter and 1.5 for ammeters. Other type of instruments direct reading shall be 1.0 for voltmeter
and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in
temperature shall be limited to a minimum. The meter shall be of flush mounting type of 96mm square
pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic
mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments
glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the
accessories with in the case shall not be possible without removal of the seal. The meters shall be provided
with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated
from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three
phase supply.
The specifications herein-after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the bill of quantities.

**DIGITAL AMMETERS**

Digital Ammeters shall be confirm to IS: 13875. It shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition.

**DIGITAL VOLTMETERS**

Digital Voltmeters shall be confirm to IS: 13875. It shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition. The voltmeter shall be provided with protection MCB of suitable capacity.

**CURRENT TRANSFORMERS**

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1KV Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring</td>
<td>1.0</td>
</tr>
<tr>
<td>Protection</td>
<td>5 P10</td>
</tr>
</tbody>
</table>

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformer shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

**CONTROL SWITCHES**

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.
CABLE TERMINATIONS-

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminium conductor power cable and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be brass compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

CONTROL WIRING-

All control wirings shall be carried out with 1100V grade single core FRLS cable conforming to IS 694/IS 8130 having stranded copper conductors of minimum 1.5 sq. mm for potential circuits and 2.5 sq. mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

TERMINAL BLOCK-

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

LABELS-

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

TESTING AT MANUFACTURING WORK-

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted to the Engineer – in – Charge.

TESTING AND COMMISSIONING-

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following:

a) Operation checks and lubrication of all moving parts.

b) Interlocking function check

c) Insulation test: When measured with 500 V meggar, the insulation resistance shall not be less than 100 mega ohms.

d) Trip tests & protection gear test.
GENERAL
a) Distribution Board shall be double door type with extended loose wire box & M.S. Junction Box at the top and suitable for flush installation. All distribution boards shall be of three phase (415 Volts) or single phase (240 Volts) type with incoming isolator or MCB and/or ELCB as in Bill of Quantities. Distribution boards shall contain plug in type miniature circuit breaker mounted on bus bars. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. MCB shall have thermal & magnetic short circuit protection. MCB shall conform with IS 8828-1978 & IS 8828 - 1996. Bus bars shall be of electrolytic copper. Neutral bus bars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Separate neutral & earth bus bar link to be provided for each phase. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. All distribution board enclosures shall have an etched zinc base stove painted followed by synthetic stoved enamel, colour light gray. A circuit identification card in clear plastic cover shall be provided for each distribution board. IK (Mechanical Stress) rating of distribution board enclosure shall not be less than IK – 07/08/09.

b) Distribution Board with single phase outgoings requirement shall be Horizontal type. Distribution Board with three phase outgoings requirement shall be Vertical/ Horizontal type. Distribution Board installed in indoor dry locations shall conform to IP-42. Distribution Board installed in outdoor & wet locations shall conform to IP-65.

c) Miniature Circuit Breakers for lighting circuits shall be of "B" series where as the circuits feeding discharge lamps (HPMV or HPSV) halogen lamps, all power outlet points, equipment/ machinery shall be of "C/D" series (Motor circuit) types. All miniature circuit breakers shall be of not less than 10KA rated rupturing capacity. All miniature circuit breaker terminal shall have safety shutter.

d) Distribution board shall be provided with isolator or MCB and/or earth leakage circuit breaker as mentioned in drawings and BOQ. Earth leakage circuit breaker shall be current operated type and of 30mA sensitivity unless otherwise stated. ELCB shall be mounted within distribution board box for single phase distribution board while in three phase distribution board ELCB shall be either mounted within distribution board box or in a separate MS box below distribution board. Width and depth of ELCB box shall be same as that of distribution board box and of same finish. Height of ELCB box shall be sufficient to accommodate ELCB & termination of incoming & outgoing wires. Distribution board box, isolator, MCB’S used shall be of one/same manufacturer. Standard size manufactured by approved manufacturer shall be used. In case size specified in BOQ is not standard size of manufacturer, in that case next standard size distribution board box shall be used with incoming & outgoing MCB as specified in BOQ. Additional cutout/space for outgoing MCB shall be plugged with blank plates. No extra cost shall be paid for using bigger/higher size distribution board box and blank plates.

CONDUIT AND WIRING SYSTEM

PVC CONDUIT

Conduits shall be heavy gauge rigid PVC of minimum thickness of 2mm. Conduits shall be ISI marked confirming to IS: 9537 (Part-3)-1983. All conduit and conduit accessories shall be of PVC. Conduit shall be jointed together by a vinylic type cement/solvents. Minimum size of conduit shall be 25mm unless otherwise mentioned in BOQ or drawing. Conduit shall be fixed on ceiling or wall. All conduits shall be concealed in wall/ceiling etc. or fixed on surface of wall with clamps at regular interval as called for elsewhere. For termination of PVC conduits into switch outlet box, PVC female adaptors shall be used. Wherever conduit run exceeds 10 metre, circular junction boxes shall be provided to facilitate pulling &
inspection of wires. Inspection boxes shall be suitably located in co-ordination with the Engineer-in-charge. Conduits shall be bend using suitable size springs. Long radius bends shall be provided. Heating shall not be used to bend the conduits. Size of conduit shall depend upon number and size of wires to be drawn.

**M.S. CONDUIT**

All conduit pipes shall be of approved gauge (not less than 16 SWG for conduits of sizes up to 32mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with stove enameled surface. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS code. No steel conduit less than 20mm in diameter shall be used unless otherwise stated.

**CONDUIT JOINTS**

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13mm to 19mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipe shall have no sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

Wherever conduit passes a building expansion joint, galvanized flexible metallic conduit shall be provided for connecting rigid M.S. Conduit in either slab.

**PROTECTION AGAINST CONDENSATION**

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

**PROTECTION OF CONDUIT AGAINST RUST**

The outer surface of conduit including all bends, unions, tees, junction boxes etc forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

**PAINTING OF CONDUIT AND ACCESSORIES**

After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

**FIXING OF CONDUITS**

**SURFACE CONDUIT**

Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other approved plugs with screws in an approved manner at an interval of not more than one meter but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30cm from the centre of such
fittings. The saddles should not be less than 24 gauge for conduits up to 25mm dia and not less than 20
gauge for larger diameter conduits. The corresponding widths shall be 19mm & 25mm. Where conduit
pipes are to be laid along the trusses, steel joint etc. the same shall be secured by means of special clamps
made of MS. Where as it is not possible to drill holes in the trusses members suitable clamps with bolts and
nuts shall be used. All fixing arrangement like saddles, special purpose clamps, nuts, bolts etc. shall deemed
to be included in quoted rates of conduit.

For 25mm diameter conduit width of clip shall be 19mm and of 20 SWG. For conduit of 32mm and above,
width of clip shall be 25mm and of 18 SWG.

Where conduit pipes are to be laid above false ceiling, either conduit pipes shall be clamp to false ceiling
frame work or suspended with suitable supports from the soffit of slab. For conduit pipe run along with
wall, the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with special clamps if
required to be approved by the Engineer-In-Charge at site.

RECESS / CONCEALED CONDUIT

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the
manner desired. In the case of building under construction, conduit shall be buried in the wall before
plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry
work, special care shall be taken to fix the conduit and accessories in position along with the building work.
Entire work of chasing the wall, fixing the conduit in chases, and during the conduit in mortar before
plastering shall form part of point wiring work. (For chase cutting-chase cutting machine shall be used and
no manual cutting shall be allowed)

The conduit pipe shall be fixed by means of stapples or by means of saddles not more than 60cm apart or by
any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as
practicable and all curves maintained by bending the conduit pipe itself with the long radius which shall
permit easy drawing in of conductors. All threaded joint of conduit pipe shall treated with some approved
preservative compound to secure protection against rust. Suitable inspection boxes to the barest minimum
requirements shall be provided to permit periodical inspection and to facilitate replacement of wires, if
necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the
inspection box covers. Wherever the length of conduit run is more than 10 metres, then circular junction
box shall be provided to facilitate pulling of wires. The chicken wire mesh shall be provided by civil agency.

OUTLET BOXES:-

Switch/outlet boxes shall be made of metal on all sides except on the front. Boxes shall be hot dip
galvanized mild steel. Upto 20 x 30cm size M.S. Box shall have wall thickness of 16 SWG and MS boxes
above 20x30cm size shall be of 14 SWG. The metallic boxes shall be painted with anticorrosive paint
before erection. Clear depth of the box shall not be less than 60mm. all fitting shall be fitted in flush
pattern. Switch/outlet boxes shall be suitable to house modular type light and power accessories. Earthing
stud to be provided for connection of earthing wire in side of box at near any corner. Nakka shall be 3 mm
thick.

FAN BOX:-

Fan Box shall be made out of 14 gauge M.S. sheet in hexagonal shape. The dia of box shall be 150 mm and
depth of box shall be 80 mm. A M.S. cover plate size 160 mm x 160mm x 16 gauge to be provided in the
back of fan box. 12 mm dia M.S. Rod to be provided for fan hanging arrangement in the box. A 28 mm dia
knockout To be made in all six hexagonal vertical part for conduit entry in the box. The box shall be
painted with 2 coat of primer. A 180 mm dia, 2 mm thick hylem sheet Cover to be provided. (The sample to be approved before procurement/execution by owner/consultant.)

**JUNCTION TEE / DEEP TEE:**

The tee shall be made out of C.I. material. The dia of tee shall be 60 mm and the Depth of tee shall be 70 mm. The thickness of deep tee wall shall be 1.3mm to 1.5mm. (The sample to be approved before procurement/execution by owner/consultant.)

**ERECTION AND EARTHING OF CONDUITS:**

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit. Gas, water pipe shall not be used as earth medium.

**LIGHT & POWER ACCESSORIES:**

**GENERAL**

All light & power accessories shall be of modular range of plate switch type and shall be of one manufacturer (brand) and type.

**LIGHT SWITCHES**

All switches for control of light shall be of 6/10 Amp unless otherwise stated. All switches shall be modular range of plate switch type. The switches shall be rocker mechanism type with silver contact. All switches shall be of white finish or as sample approved by owner/consultant.

**6/16 AMP SWITCH SOCKET OUTLET.**

Switch socket outlet on lighting circuit outlet shall be of 3 pin 6Amp outlet shall have safety shutters. The switch shall be of rocker mechanism type with silver contact. Socket outlet shall be shutter type and of modular range of plate type and having white finish. Switch and socket outlet shall be mounted on a suitable size GI box with suitable size modular cover plate.

Switch socket outlet on power circuit shall be of 6 pin 16/6 Amp outlet (Universal Socket) shall have safety shutters. The switch shall be of rocker mechanism type with silver contacts. Socket outlet shall be shutter type and of modular range of plate type and having white finish. Switch and socket outlet shall be mounted on a suitable size GI box with suitable size modular cover plate.

**TELEPHONE OUTLET**

Each Telephone outlet location shall be provided with 1 No. telephone Jack type outlet (RJ11). The telephone outlet shall be of modular range of plate switch type and shall be mounted on a suitable size GI Box with modular range cover plate.

**WIRING**

All FRLS insulated copper conductor multi-stranded wires shall conform to relevant IS codes. Cable conductor size and material shall be as specified in BOQ.
All internal wiring shall be carried out with FRLS insulated wires of 1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switch board may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switch boards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red or yellow or blue colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour FRLS insulated wire for RYB phase wire respectively and black colour FRLS insulated wire for the neutral wires. FRLS insulated green colour wire shall be used as earth continuity conductor and shall be drawn alongwith other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing & jointing of copper conductor wires & cables shall be as per CPWD specifications.

**JOINTS**

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits & junction boxes. Conductors shall be continuous from outlet to outlet.

**SUB MAINS**

Sub-main wiring shall be carried out with FRLS Insulated Copper multi-stranded wires/cables in suitable M.S Conduit unless otherwise specified in BOQ / drawing.

Sub-main cable where called for shall be of the rated capacity and approved make. Every sub-main shall be drawn into an independent adequate size conduit. Adequate size draw boxes shall be provided at convenient locations to facilitate easy drawings of the sub-main cables. Cost of junction box/drawn box is deemed to be included in the rates of sub-main wiring. An independent FRLS insulated copper earth wire of proper rating shall be provided for every sub-main. Single phase sub-main shall have single earth wire whereas three phase sub-main shall be provided with two earth wire.

Where sub-mains cables are connected to the switchgear, sufficient extra lengths of sub-main and mains cable shall be provided to facilitate easy connections and maintenance. For termination of cables crimping type cable socket/lugs shall be provided. Same colour code as for circuit wiring shall be followed.

**LOAD BALANCING**

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

**COLOUR CODE FOR CIRCUIT & SUB-MAIN WIRING**

Colour code for circuit & sub-main wiring installation shall be Red, Yellow, Blue for three phases. Black for neutral and green for earth in case of insulated earth wire.

**CLASSIFICATION OF POINTS:-**
**General**

Classification and measurement of Point wiring shall be as follows:

Conduiting & wiring from switch to first point including circuit wiring along with conduits, shall be classified as “One point (First point) controlled by one number 6Amp one way/two way switch”.

Conduiting & wiring from first point to next point to be controlled by same switch in same circuit shall be classified as “Looping Points”.

**CONDUCTOR SIZE**

Wiring shall be carried out with following sizes of FRLS insulated multi-stranded single core copper conductor wire/cable.

<table>
<thead>
<tr>
<th>Light point</th>
<th>1.5 Sq.mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling/Cabin/Exhaust Fan Point</td>
<td>1.5 Sq.mm</td>
</tr>
<tr>
<td>Plug Point (5 A SS outlet)</td>
<td>1.5 Sq.mm</td>
</tr>
<tr>
<td>Circuit Wiring</td>
<td>2.5 Sq.mm</td>
</tr>
<tr>
<td>MCB Control Light Point</td>
<td>2.5 Sq.mm</td>
</tr>
<tr>
<td>General Power Point (15A S.S. outlet)-First Point</td>
<td>2.5 Sq.mm</td>
</tr>
<tr>
<td>General Power Point (15A S.S. outlet)-Second Point</td>
<td>2.5 Sq.mm</td>
</tr>
<tr>
<td>Power Point for Geysers/A.C. Unit</td>
<td>4.0 Sq.mm</td>
</tr>
</tbody>
</table>

**TELEPHONE WIRE/CABLES:-**

Separate conduits shall be provided for internal telephone wiring of telephone system commencing from tag block. Each telephone outlet shall be wired with 2 pair telephone cable from the tag block. All telephone wires shall be of 0.5mm dia annealed tinned high conductivity copper conductor PVC insulated & PVC sheathed grey conforming to ITD specification SWS 113 B&C. Multipair PVC insulated cables laid in conduit shall be provided for connecting various tag blocks. Telephone cables used for external connections shall be armoured. These cable shall be laid directly in ground or in pipe etc. as call for elsewhere.

Following number of 2 pair wires/cables shall be drawn in various sizes of conduits as listed below.

<table>
<thead>
<tr>
<th>25mm conduit</th>
<th>Up to 6 Cables</th>
</tr>
</thead>
</table>

All telephone cables used in the building shall be PVC insulated PVC sheathed.

**TELEPHONE DISTRIBUTION BOARDS (TAG BLOCK):-**

Tag block shall be mounted in M.S. box fabricated from 1.63 mm thick sheet steel. Box shall undergo a rigorous metal treatment process i.e. degreasing, pickling, phosphating, pasivating in de oxalate solution, dry with compressed air in dust free atmospheric facility and disconnection module shall be in multiple of 10 pairs. Disconnection unit shall be mounted on back mounting frame.

**SUPPLY AND INSTALLATION OF LIGHT FIXTURE:-**

**SUPPORTS AND FIXINGS**
Where fluorescent luminaries 1200 mm or more in length are supported directly by the conduit system they shall be fixed with light point junction boxes of which shall form an integral part of the conduit system.

Where the weight of the luminaire is supported by a conduit box or cable trunking the fixing of the conduit box or trunking shall be adequate for the purpose and approved by Architect/Consultant. Luminaires fitted with tungsten filament, lamps and having metal back plates shall not be fixed directly to conduit box in which a thermoplastic material is the principal load-bearing member.

Support of luminaires from cable trunking shall be by means of appropriate clamps or brackets. Luminaires mounted on or recessed into suspended ceilings shall not be support on the false ceiling unless specifically shown and approved.

For wall mounted luminaires, the mounting height specified on drawings shall be above finished floor level measured to the centre of the conduit box, unless otherwise indicated.

**WIRING CONNECTIONS**

Where luminaires, other than those are fixed direct to circular boxes or supported by pendants or chains, the final circuit wiring shall terminate at a terminal block in the conduit box.

Where luminaires having fluorescent tubes are fixed direct to circular conduit boxes, the final circuit wiring may be terminated within the luminaire unless otherwise indicated. The wiring shall enter each luminaire at the conduit entry nearest to the terminal block and where the loop – in wiring system is used leave by same entry wiring shall not pass through a luminaire.

Where luminaires are mounted on or recessed into a suspended ceiling connection shall be by flexible cord from a plug in ceiling rose shall be located not more than 500 mm from the access panel in the ceiling and shall be firmly supported, unless otherwise approved by the consultant.

Cables and flexible cords for final connections to luminaires shall be suitable for the operating temperature of the luminaire. Flexible cords for chain suspensions, if any shall have a white sheath unless otherwise indicated.

The size of final connection cables or flexible cords shall be as indicated.

Cables and cords passing close to ballast within a luminaire shall be suitable for the operating temperature of the ballast. Heat resistant sleeves shall be provided.

A protective conductor shall connect the earthing terminal or earthing contact of each luminaire to an earthing terminal incorporated in the adjacent conduit box. Where the final connection is by flexible cord the protective conductor shall form part of the cord.

Where luminaires are recessed in the false ceiling, luminaires shall be suspended with MS conduit with ball & socket arrangement, check nut etc. Suspension arrangement shall be fixed to steel/RCC structure with suitable purpose made clamps etc. (Cost of suspension arrangement is deemed to be included in the rate of installation/erection of luminaires). Contractor shall submit the shop drawing for proposed suspension arrangement of various types of light fixtures in various type of ceiling and shall obtain necessary approval from the Engineer-in-Charge.

The light fixtures and fans shall be assembled and installed in position complete and ready for service in accordance with the detailed drawings, manufacturer’s instructions and to the satisfaction of the Engineer-in-Charge. Fixtures shall be suspended true to alignment plumb level and capable of resisting all lateral and vertical forces and shall be fixed as required. All ceiling fans shall be provided with suspension
arrangement in the concrete slab/roof members. It shall be the duty of the contractor to make these provisions at the appropriate stage & locations shown on the drawings. Fan box with MS hook shall be as per CPWD specifications. Suspended type fluorescent light fixture shall be fixed to circular junction box with a metallic ball and socket arrangement. Light fixture in general shall be directly fixed to ceiling slab with rawl plugs. All switch and outlet boxes shall be bonded to earth through connector blocks. MS pipe shall be fixed with suitable fixing accessories and metal continuity shall be maintained.

CONDUITING AND WIRING FOR SAMTV SYSTEM:-

CONDUITING

Conduiting for SMATV system shall be carried out in M.S. Conduit. Conduiting shall be carried out as specified in point wiring head.

OUTLETS

All SMATV outlets shall be provided with modular range of cover plate, box and coaxial outlet. Cover plate shall match in shape & finish with other light and power accessories.

JUNCTION BOX

Suitable size of metallic junction box shall be provided for termination of conduit for SAMTV system. Box shall be made of 1.6mm thick MS sheet and shall be treated before painting. Front of the junction box shall be provided with 3mm thick phenolic laminated sheet cover.

COAXIAL CABLES

The coaxial cable shall be of wideband type (RG-11 for Riser & RG-6 for distribution)

TAP OFF

These shall be of ultra wide bandwidth and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have a aluminium cast housing for high frequency radiation resistance.

The Tap offs shall be in one way, two way and four way configurations.

SPLITTERS

These shall be of ultra wide band width and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have a aluminum cast housing for high frequency radiation resistance.

The splitters shall be in 2 way, 3 way & 4 way configurations

LIGHTNING PROTECTION

GENERAL

1. The advance lightning protection system shall be of the enhancing type designed to attract lightning from a predetermined volume and to safely convey the lightning current to earth through a known and preferred route.

2. The lightning protection system shall include components as follows: air termination(s) mechanical support(s), down conductor (s), performance recording equipment, and low impedance grounding system.
3. The Advanced Lightning protection system shall be mounted adequately rated for wind shear loading. Guying kits shall be provided as appropriate to local environmental conditions, or based on mast arrangement selected.

4. The Advanced Lightning protection shall be designed by a company engaged in the manufacture and development of Advanced Lightning system components, of types, sizes and ratings as shown, who can show evidence or support that their products have been in satisfactory service for not less than 10 years.

5. The lightning protection components (Air termination(s) and down conductor(s)) shall be compliant to UL-96.

**AIR TERMINATION**

1. The air termination shall be Controlled Leader Triggering / Controlled Streamer Emission (CSE) terminal.

2. The air termination shall be working on the principle of **Collection Volume Method Placement** and **Electric Field Intensification** which responds dynamically to the appearance of a lightning down leader by creating free electrons needed to initiate an upward streamer and sudden increase in the electric field above the air terminal which provides the additional energy to initiate and convert s strong propagating upward leader.

3. The air terminal should have variable impedance unit for discharging the static charges into the ground during the buildup stage in the atmosphere.

4. The air termination shall be non-radioactive.

5. Arcing is not to be continuous and shall only occur during the progress of the lightning leader. Arcing shall not occur solely due to electrostatic field when a thunderstorm is overhead except when there is leader activity in the region.

6. The external shape of the terminal shall be of Stainless Steel Semi Spherical type in order to significantly reduce the buildup of sharp point corona discharge under static field thunderstorm conditions.

7. The air termination shall be passive terminal not requiring internal or external power source for its operation. It shall have no moving parts and the materials of the air termination shall be non-corroding in normal atmosphere.

8. The materials of the air termination shall be non-corroding in normal atmosphere. The centre earthed finial shall be at least 300mm² in cross section and be made of electric grade non ferrous material. The outer metallic surfaces of the terminal shall be manufactured of anodised aluminium.

9. The air termination shall be insulated from the protected structure under all conditions.

10. The size of the collection volume and attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

11. The termination shall be mounted a minimum of 10 metres from the ground.

12. The air termination(s) shall be compliant to UL-96: Lightning Protection Components (Standard for Safety).

13. The air termination shall be installed strictly to the manufacturer's instructions. It shall not be installed in corrosive environments or atmospheres without prior written approval from the manufacturer.

The protective zone provided by the air termination shall be such that it becomes the preferred strike point for all discharges exceeding a peak amplitude return strike current of $X \text{ kA}$ according to the statistical level $Y$ per IEC61024. The design shall take account of upward leader competing projections on the structure.

<table>
<thead>
<tr>
<th>Strike Current (X)</th>
<th>Levels of Protection (Y)</th>
<th>Exceedance Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9 kA</td>
<td>Protection Level I – Very High</td>
<td>99%</td>
</tr>
<tr>
<td>5.4 kA</td>
<td>Protection Level II- High</td>
<td>97%</td>
</tr>
<tr>
<td>10.1 kA</td>
<td>Protection Level III – Medium</td>
<td>91%</td>
</tr>
<tr>
<td>15.7 kA</td>
<td>Protection Level IV – Standard</td>
<td>84%</td>
</tr>
</tbody>
</table>
AIR TERMINATION SUPPORT

The air terminal support shall consist of a minimum of 2m of insulating re-enforced fiberglass cylindrical mast. The conductor shall pass through the centre of the mast, with the high voltage termination contained to the upper 1m of the mast.

The support shall be securely bolted to other mast materials with guy wires used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

DOWNCONDUCTOR

1. The down conductor shall consist of a plastic filler, copper conductor, inner insulation, outer copper conductor, conductive sheath, all concentrically arranged.
2. The characteristic of the Down Conductor should be as follows:
   i. Characteristics impedance of less than 12 Ω.
   ii. Inductance of 37 nH/m.
   iii. Capacitance of 0.75 nF/m.
   iv. Upper Termination Voltage Withstand of 250 kV.
   v. Resistance RDC of 0.5 mΩ/m and RIMPULSE of 6 mΩ/m
   vi. Cross sectional Area of 55 sq. mm
   vii. Maximum diameter of 36 mm.
   viii. Weight of 1.2 kg/m.
3. The Down Conductor should discharge the lightning current to the ground with minimum danger of side flashing.
4. The down conductor shall be installed in accordance with the manufacturer's instructions and should not be subject to bends of less than 0.5 metres radius.
5. The down conductor after routing, must be kept in constant physical contact with the structure via conductive clamps. The top 10% of the installed length from the terminal must be anchored at least every 1 metre. The lower must be anchored at least every 2 metres.

Performance recording equipment

Each protection system shall be supplied with a lightning event counter. The lightning event counter shall have a register that activates one count for every discharge where the peak current exceeds 1500A. The test wave shape shall be the 8/20us standard as defined by ANSI C62.41

The lightning event counter shall be robust, easy to install and housed in an IP67 rated enclosure. The counter shall operate from the energy of the lightning discharge and not rely on external or battery power to operate.

The lightning event counter shall be installed to the manufacturer’s instructions in a readily accessible manner so that readings can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -10°C to +50°C.

Lightning Protection Maintenance Free Earth:

The grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the Advanced lightning protection system.

The earth should be done with minimum 4 nos of Copper Bonded Ground Rods of 250 Microns with 5 ft length and 5/8” diameter in single line or square depending on site conditions.
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

The earth rods be grounded and joined with minimum 25 meters of 99.9% pure 25 mm x 3 mm Copper Strip.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building and to arriving services is recommended. The resistance should be measured and the 10 ohms maximum figure achieved before such bonding is done.

Electrically conductive, non soluble Earth Enhancing Material may be used to help achieve low ground resistance provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

FIRE ALARM SYSTEM

DESCRIPTION:

The work shall consist of furnishing, installation, testing & commissioning of a complete high quality advanced technology early detection Intelligent Analogue Soft Addressable fire alarm system as shown on the drawings and specified herein.

REFERENCES FOR INSTALLATION:

German Standards VDE (Verband Deutcher Elektrotechniker) DIN VDE14675 and VDE 0833 Fire Alarm Systems
NFPA- National Fire Protection Association NFPA 72
British Standard Institute / European Standards
All Applicable codes and standards including BS EN 54

SUBMITTALS:

A. Product data for fire alarm system components including dimensioned plans, sections, and elevations showing minimum clearances, installed features and devices, and list of materials and data.
B. Shop drawings.
C. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs. Description shall cover this specific project.
D. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with any one of the referenced standards, completely with specifications and Vds approval/UL.

TRANSPORTATION, HANDLING AND STORAGE:

A. All the components of fire alarm system shall be provided in manufacturer’s original new and unopened
packing bearing manufacturer’s name and label.

B. Store materials, not in actual use, in covered and well ventilated area and protect them from dirt, dust, moisture, direct sunlight and extreme temperatures.

C. For further requirements follow manufacturers written instructions regarding storage and handling.

**WARRANTY**

A. Submit written guarantee signed by the contractor, manufacturer and installer of fire alarm system for the period of 1 year from the date of substantial completion. The guarantee shall cover the repair and replacement of material with manufacturing defects and workmanship as directed by the engineer.

**QUALITY ASSURANCE:**

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of fire alarm systems and components, whose products have been in satisfactory use in similar services for not less than 3 years period, and be subject to approval of engineer.

B. Installer Qualifications: An experienced specialist sub-contractor who is authorized by the system manufacturer, and subject to approval of the engineer.

C. All the components and installations shall comply with the requirements of DIN VDE 14675 & VDE 0833/NFPA for design & installation.

D. Provide system and components specified in this section that are listed and approved by Vds & conform to equivalent DIN/EN/UL standards.

E. Single source responsibility: All components and accessories shall be product of single manufacturer.

**SYSTEM DESCRIPTION:**

A. The fire detection and alarm system shall comprise of Automatic Soft Addressable Modular design main fire alarm control panels, Dual optical smoke & heat MULTI Sensors, Blue LED Optical Smoke & Heat MULTI Sensors, Optical Smoke / Heat / CO Gas MULTI sensors, Loop powered Dual Optical Smoke/Heat sensor with integral Sounder / Flasher / Speech units, manual call points, electronic wall mounted Alarm sounder/flasher/speech combined devices, Transponder interface units, each with its own short circuit built-in isolators. All loop cabling and any other components and accessories deemed necessary for a safe, reliable and satisfactory system shall conform to the relevant and applicable requirements and recommendations of DIN EN 54. The system shall be fully programmed to accommodate fire alarm zones. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to existing buildings/network on site.

B. The fire alarm and detection system shall provide the following facilities as a minimum:

The system shall be intelligent in operation with advanced decentralised intelligence technology. Each detector shall have its own processor with algorithms built in the device to take a fire or fault decision. System with centralised intelligence by providing signal levels to the control panel are not acceptable.

The system will be capable of providing fire, fault disablement and supervisory monitoring facilities as required by DIN EN 54 Pt 2. All devices on a loop shall have built in SHORT CIRCUIT LINE ISOLATORS for wiring fault isolation to protect the system. “Group Circuit Monitors” which isolate/protect sections of a loop circuit, i.e. a group of field devices are not acceptable.

All system components and devices shall be connected to two-wire loop circuits (as shown in the typical schematics) with each component having its own individual built-in isolator, should have sensors with integrated sounder in a same unit and no extra cabling should require to power up the sounder. Removal or
disconnection of any component from the loop shall not affect the functioning and performance of other components and the system. Please note that the group isolators, which are used to isolate a section of a loop in case of fault, are not acceptable.

System shall be of automatically addressable type i.e. all the devices on the loops of the FACP shall be allocated addresses automatically from the PC / panel at the time of system power. The loop devices shall also be able to commission by using PC interface without the need of FACP.

And also given an address during commissioning, the value of which shall be stored in non-volatile memory, within the electronics module of the outstation. This value shall be read during loop allocation and provided it is valid shall be used to setup the outstations primary address.

Automatic Addressing shall cover the benefits of Soft Addressing and also overcome the limitations of Hard Addressing. This means that If the devices are inserted or removed all the existing devices shall keep the same address and programmed activations and use labels remain unchanged. The panel with PC shall allocate the address to ensure that it is impossible for two devices to have the same address. Fire Detection and Alarm Systems, which rely only on Coding, Programmer or hard addressing techniques are not acceptable.

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions:
- The power supply to the loop / s;
- For open-circuit, short-circuit, earth fault and any other fault condition in the loop wiring;
- For communication failure and errors in all cards and loops
- For faults in keyboard and printer circuits
- All devices, etc. shall be installed on the same loop.

All devices shall be assigned a maximum of 25 character or 2 lines of max. 30 characters each with a ¼ VGA Display. In case of fire, fault or warning, the label of device sensing threshold shall appear on visual display unit of the panel.

Any event i.e. Fire, fault or warning shall be recorded with time, date and place of occurrence in the memory of FACP. These events can either be displayed on normal or ¼ VGA Display of the FACP or printed, as required. Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is reset. The detectors shall have auto learn sensitivity adjustments. The main fire alarm control panels shall be located as shown on the schematics and the floor drawings.

GENERAL
All major component of fire alarm system shall be product of a single manufacturer and shall conform to the requirement of EN54, Vds,UL approved and be designed acc. to DIN VDE14675 and VDE 0833/NFPA Fire Alarm Systems CODE OF PRACTICE FOR SYSTEM DESIGN, INSTALLATION AND SERVICING.

The power supply breakers for FDA system shall be marked “ DO NOT DISCONNECT. FIRE ALARM SUPPLY”

ANALOGUE ADDRESSABLE FIRE ALARM CONTROL PANEL (FACP)
A. In the event of a fire being reported from the smoke/heat Detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows: If a fire condition is reported from a smoke detector then the evacuation will be done initially by the local integral sounder. Then after a certain delay (to be agreed at the time of commissioning) the evacuation message shall be announced on that fire zone only. If after 3 minutes the alarm has not been acknowledged, the evacuation message shall also be announced on the other adjacent zones. All other zones shall be given the Alert message. The evacuation of the building shall be staged in phases to allow orderly movement of people.
B. If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected fire zone plus the adjacent zones.

C. Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as a part of the overall engineering policy.

- Signal to all elevator machine rooms indicating fire status (to control lifts)
- Release doors normally locked by magnetic devices.
- Release doors normally held open by magnetic devices
- Shutdown mechanical equipment ventilation plant
- Shutdown general exhaust fans
- Start up smoke extract fans
- Start up exhaust make up fans
- Start up stair vestibule pressurization fans
- Automatically operate fire dampers
- Initiate alert signals to panels in the adjacent office tower.
- Sprinkler valves, flow switches and other monitored valves shall be directly supervised by the fire alarm systems.

These shall include but not limited to the following:

- Building automation system via WINMAG OPC
- Emergency lighting system
- Security system.

SYSTEM COMPONENTS AND DEVICES

FIRE ALARM CONTROL PANEL:

A. The panel shall be modular Multifunctional computer controlled using 32 bit processor. Decentralised control and monitoring functions to be realised on the loop and spur. The panel shall be complete with, but not limited to, the following elements:
1) Visual display unit capable of displaying 8 lines 40 characters backlit display / ¼ VGA display as optional.
2) Built-in optional 40 character internal protocol thermal printer or external.
3) Built-in full numeric keyboard with function keys.
4) 64 Single Zone Indicator expandable up to 192 SZI
5) USB Port
6) Ethernet connection
7) SMART Card media slot.
8) Keypad to prevent unauthorised operation of keypad.
9) Integral sealed lead acid battery and charger, with 24 hour back up in the event of supply mains failure.
10) Essential controls – Delay, panel reset, Audible alarm off, Disconnect master box, additional messages, verify/cancel fault buzzer. Fire, Pre-Alarm, Trouble, Disconnection lamps. Each lamp shall also have appropriate indication (Releasing Systems activated, Master box, Delay, Verify, CPU failure, Inoperation normal condition & failure of powersupply / battery) Simple menu driven function keys with password protection shall allow users to an extensive range of software based features such as:

- Overview
- Service
- Time functions
- Informations
- Last 10000 system events
- Current fault and warning logs.
- Interrogation of sensor cleanliness
  - On/Off, Enable/ disable sensors, zones, sounders, interface unit channels.
- Status of detectors
- Alarm counters
- Printer on, off, line feed and test facilities.

11) All control buttons and keyboard shall be enclosed behind a lockable cover, Up to 127 device capacity per 3.5km loop and a TTY/ RS 485 communication option.

12) In addition to the above, all other necessary controls, elements and accessories shall be included to provide a complete and efficient panel conforming to the requirements of DIN EN 54/UL.

13) LOOP PARAMETERS:
    Individual loop circuits will be capable of accommodating the following.
    - Up to a maximum of 127 addressable devices up to 3.5 kms loop length
    - Up to 32 loop powered IQ8 Alarm addressable Sounders.
    - Up to 32 loop powered IQ8 Alarm electronic Strobes.
    - Up to 32 loop powered combined electronic sounders and strobes
    - Up to 80 sensors with integral alarm sounder
    - The detection loop shall have the ability to support both sensors and sounders connected on the same 2 core loop circuit.
    - Up to 127 loop powered input modules.
    - Should have the ability to spur off the detection loop without using ‘T’ breaker devices, without any degradation.

CENTRAL GRAPHICS SUPERVISOR COMPUTER:

The graphic visual display shall pictorially represent Fire, Fault and Emergency events on a visual display unit (VDU). The purpose of this facility shall be to provide the operator with the additional visual information over and above the text provided. All system events i.e. fire, fault and warning shall be automatically printed onto the graphics printer. Operation of the graphics terminal shall normally be by selection of the appropriate pages guided by a navigation system. However, it shall automatically track to the relevant initiating device for the first occurrence of each type of the event. The graphics terminal shall provide the following:

- DUAL LANGUAGE ENGLISH / ARABIC.
- Single Station version
- Multi Station Version
- Multi Networks
- Modem Interface
- Communications shall be bi-directional
- Free programming of alarm programs and alarm condition through SIA programming

Software shall have software interface using drivers with:

- Intruder Alarm Panels
- Fire Alarm Panels
- Video System
- Access Control System
Web Function: PC on Intranet/Internet using a common Web-browser shall be able to access the software with password.

Notification: Software shall be capable of transmitting text and voice messages to specific devices like cell phones, pagers etc.

Escalation: Software shall be capable of starting escalation action if within certain/configured time period the notification is not acknowledged.

Integration of IP telephony shall be possible at least with ALCATEL to have innovative linking of telephony via IQphone enabling the end-user devices to be used as multifunctional operating and display terminals with variable adaptation of applications.

HTML View: Applications such as Video streaming or BMS programs which have a Web server available shall be visualised clearly by Supervisor Software browser window USING Supervisor Interface.

Events display/status bar giving a clear and concise view of the current events on the fire alarm system, Intrusion CCTV or ACCESS control.

- Ability to control and change the following:
  - Disable actions
  - Labels & Auxiliary text
  - User Action buttons
  - Historic data of all the system events
  - Access levels/passwords to target specific levels of access to specific users
  - Graphical representation (if required) of the site allowing the exact location of the fire alarm events, e.g., fires, faults etc.
  - Panel remote buzzer cancellation
  - Event acknowledgement
  - Clock synchronization with panels with local adjustment facility
  - Touch screen support

The terminal shall assign a number of different graphic pages to each fire event – from a site overview of building layout, through a floor layout, breaking the site down into increasing levels of detail. Number of graphic pages required shall be finally determined by the client/consultant. For tender assume 4 pages per floor, based on the drawings produced on AutoCAD by the Contractor.

The system shall operate on the Windows environment. The platform specification required is an IBM PC compatible with the following minimum specifications.

- Pentium IV Processor, 1GHz speed
- 256 MB RAM, 1 GB Hard Disk
- XGA-graphic card with min. 4 MB video memory
- Minimum 14 super VGA color screen
- Two serial ports and two parallel ports & Real time clock
- 3.5 inch 1.44-MB floppy disk
- CD RW & Microsoft mouse

The combined text and graphics package shall be provided on the same supervisor. The supervisor with touch screen is recommended.
SYSTEM EVENT PRINTER

A. The system printer shall be 40 character thermal printer optional in-built on the main control panel, and shall log all events, change of status, alarm and fault messages along with time of the day and date. An external 80 couloum dot matrix printer along with system PC is also recommended.

The printer shall provide the following:

- Hard copy of every event occurring
- Status read out of every addressable point
- Devices tested on a walk test
- Contaminated detectors needing replacement
- Single point scan printout of analogue values
- Hard copy of historic log.

FIELD DETECTION DEVICES

GENERAL: ANALOGUE DETECTORS & BASES

All analogue detectors and bases shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible.

All analogue detectors shall have real intelligence itself. This means even without control panel the detector can make decision, adapt to different environmental condition and diagnose itself. They shall have decentralized intelligence, automatic function self test, CPU failure mode, alarm and operating data memory and integrated short circuit line isolators. The detector bases for interfacing between the loop wiring and the detector head shall be manufactured by means of injection molded ABS plastic coloured white and shall not contain any electronics for addressing. The base fixings should be suitable for any industry standard BESA or conduit boxes. All bases shall include the option to provide a programmable relay output for interfacing, providing a dry contact for third party. All bases shall be provided with a plastic removable dust cover for protection during site construction as well as an IP rated sealing gasket to prevent dirt and moisture from entering through from the fixing surface. Each base shall include a lock and removal of locked detectors shall be achievable only through the use of the appropriate removal tools as specified by the manufacturer of the detectors. Detectors removal tools are to be handed over on completion of the contract as part of the spare parts to the client.

Removal of a detector from it’s associated base shall not affect the continuity of the detection loop.

The Fire alarm manufacturer shall have the complete range of following analogue ADDRESSABLE detectors with decentralized intelligence as standard so as to meet the specific applications of the site.

a) Heat Detectors (fixed & ROR temperature)
b) Optical Smoke Detector
c) Optical Smoke & Heat Detector
d) Dual angle Optical/Heat Detector
e) Blue Light Optical / Heat Smoke Detector
f) Optical Smoke, Heat & CO gas Detector
g) Manual Call Points
All of the above shall be compatible with the aforementioned base providing inter-changeability between detector heads, without the requirement for switch settings. All detectors shall also have an integral short circuit isolator, which in the event of a single cable fault will isolate the "culprit" piece of cable and retain all devices on the loop operationally.

Each detector shall possess two integral LED giving a red flashing indication for fire and green for normal operation. For remote locations, each detector shall be capable of connection to a remote LED unit by means of 2 core wire connection. Detectors shall be white in colour and manufactured from ABS plastic. All electronics and associated sensing elements will be housed within this unit, these components being hermetically sealed to prevent their operation from being impaired by dust, dirt and humidity. The sensitivity of all detectors shall be adjustable from a software. It shall be possible to programme detector sensor sensitivity directly on the loop using interface with a laptop PC and appropriate programming software from manufacturer.

For MULTI SENSOR detectors, disablement of each sensor element shall be possible individually or for whole loop. Also this disablement feature shall be possible to have manually or time / event controlled.

All detectors shall be provided with a plastic removable dust cover for protection during site construction. A semi-flush recessing kit for analogue detectors shall be available for each detector type incorporating the standard detector base.

HEAT DETECTORS

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 and shall be VdS /UL approved. This shall be a dedicated heat only detector to provide fixed temperature heat as well as rate of rise sensing. It should be fully compliant with EN54 part 5 to provide grades of A1.

OPTICAL SMOKE DETECTOR:

Install as shown in the drawings. Analogue Addressable Optical Smoke Detectors. These shall be of Automatic addressable Optical type with inbuilt isolator in a single head. The optical element shall detect visible smoke from slow smoldering fires. Smoke sensing design shall comply with EN 54 part 7 and shall be VdS/UL approved. It shall have microprocessors, short-circuit isolators and all electronic components and circuitry suitable for an Analogue addressable system. The detectors shall also have 360 degree viewing LED fire indicator. Detectors mounted in the false ceilings shall be provided with semi flush mounting kits.

OPTICAL SMOKE /HEAT DETECTOR

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS/UL approved. These detectors shall have combined two individual sensing elements to provide excellent cover for both types of fires (slow smoldering & fast free burning fires). These detectors shall be of Automatic addressable Combined Optical/Heat type with inbuilt isolator in a single head.

Optical sensing shall be carried out by means of an Infra-red LED transmitting a pulse of light across an obtuse angled chamber & heat sensing shall be carried out by a thermistor, sampling the surrounding environmental temperature.

DUAL ANGLE OPTICAL/HEAT DETECTOR
Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS/UL approved. This device shall combine two individual sensing elements to provide excellent cover for both “types” of fires. (Slow shouldering and fast free burning). OPTICAL SENSING: Shall be carried out by 2 infra-red LED transmitters across 2 separate Optical detection angles. This sensor shall process both the forward and backward scattered Light caused by entering the detection chamber of device, allowing the detector to Differentiate between real smoke and non-smoke particles e.g. Steam & Dust.

HEAT SENSING: Shall be carried out by a thermistor, sampling the surrounding environmental temperature.

OPTICAL SMOKE / HEAT / CO DETECTOR

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7. The sensor element of the optical/heat detector with CO shall be as per the specification for the optical/heat detector. The CO element shall be incorporated into the optical chamber to sense the presence of carbon monoxide gas emissions from shouldering fires. In normal environments the CO element shall have a life expectancy of a minimum of 5 years.

MANUAL CALL POINTS

Install as shown in the drawings. The manual initiation devices shall be electrically compatible with all of the aforementioned detector types and shall be complete with all electronic components and circuitry for an automatic safe addressable device. The manual call point shall have an inbuilt short circuit isolator and an inbuilt microprocessor to ensure a response time of less than 1 second.

The MCP unit shall also handle all communication to the control panel. All electronic devices contained within the MCP shall be hermetically sealed so as to prevent damage from hostile environment conditions: e.g dust with minimum rating of IP43.

The MCP operating voltage shall be 8-42 volts DC, RED similar to RAL 3020. If the MCP are located in public areas a transparent cover shall be provided as a protection to prevent inadvertent activation. MCP shall be available in two designs Large & small for aesthetic purposes to architects.

The MCP shall have an input facility to connect conventional devices. It should have an option of using either frangible glass allowing for complete removal upon operation or plastic pane resettable function. There shall be no text but SYMBOLS on the MCP ( burning house / press to break ).

The device can be tested functionally without the need to either remove the front cover and/or breaking the glass, with a special test key (supplied as standard). The key shall insert the underside of the MCP ensuring easy access of the key at all times.

These devices will comply fully with EN 54 part 1.

FIELD ALARM DEVICES
Electronic sounders, combined sounder/strobe and standalone strobes shall be loop

Powered for direct connection to the 2 core detection loop shall be electrically compatible with all initiation devices. These wall mounted units shall be available in red or white and suitable for both indoor and outdoor applications with an ingress protection rating of IP31 and IP65 respectively.

All electronic sounders, sounder/strobe and strobe only versions shall have alarm signals synchronized across all the detection loops of the fire alarm control panel. All alarm devices shall have a short circuit isolation device provided as an integral component of the device.
All sounders shall have a ‘soft start’ feature controlled by the fire alarm panel, whereby a low initial volume can be set and then increased at a defined rate up to a maximum volume setting.

All alarm devices shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible. The Fire alarm manufacturer shall have the complete range of following alarm devices with built in short circuit line isolators so as to meet the specific applications of the site.

- a) Addressable Sounder
- b) Addressable Flasher
- c) Addressable Sounder / Flasher
- d) Addressable Speech Sounder
- e) Addressable Sounder / Flasher / Speech

ADDRESSABLE ALARM SOUNDER

Alarm sounders shall be capable of providing a minimum sound level of 97dBA ± 2dBA @ 1meter.

The sounder shall be capable of providing 4 different sound signals, which are selected/configured from 19 tone types stored in the device.

Each sounder shall include its own microprocessor to handle loop communications and monitoring of the internal sound element during an alarm condition. This shall allow faulty devices to be automatically identified during the weekly test procedure. All associated electronic components shall be hermetically sealed to provide protection from hostile operating environments.

It shall be possible to connect up to 32 Addressable Alarm sounders to each detection loop of the fire alarm control panel. These devices will comply fully with EN 54 part 3.

FIELD INTERFACE TRANSPONDERS

These devices shall be directly connected to the loop, four variants shall be available as standard, these being:

(i) 4 In / 2 Out interface unit
(ii) 1 In interface unit
(iii) 32 LED output interface unit
(iv) 12 Relay output Interface unit.

These units shall be self-contained wall mountable units, similar in finish to the main control panel.

(i) 4 In / 2 Out interface unit

Interface units shall be capable of accepting 4 input signals, 2 output signals. Dependent upon the specific application, input signals may be interpreted by the system as any of the following:

- Fire signal input
- Fault signal input
- Supervisory signal input
- Event signal input

The exact nature of which shall be selected by means of the commissioning software. These units will accept and or supply clean contact signals either normally open or normally closed (configurable) OR switched voltage inputs from conventional detectors or MCP’s.
The output contacts shall be rated at 30V / 1 amp. DC output of the unit shall be provided with single pole change over contacts for control of plant, door release units or power output to drive conventional bells, sounders etc. Both the outputs on the interface shall be individually programmable. External power supply 12V / 24 VDC shall be provided to this unit.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signalling and loop communications. Product shall be approved by VdS.

(ii) **1in interface unit**

Interface units shall be capable of accepting 1 input signal. Dependent upon the specific application, input signals may be interpreted by the system as any of the following:

- Fire signal input
- Fault signal input
- Supervisory signal input
- Event signal input

The exact nature of which shall be selected by means of the commissioning software.

These units will accept and or supply clean contact signals only, either normally open or normally closed (configurable). No switched voltage inputs or outputs will be accepted.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications.

(iii) **32-LED output interface units**

These interface units contain 32 outputs for triggering LEDs of e.g. mimic panels. Each output can be freely programmed with the commissioning software. The outputs are selectable as positive or negative signals. There shall be possibility to test the outputs/LEDs manually with e.g. a button.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signalling and loop communications.

(iv) **12-Relay output interface units**

These interface units contain 12 clean relays which are individually programmable with the commissioning software. All relays can be configured as NO or NC.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signalling and loop communications.

**NETWORKING OF CONTROL PANELS**

It shall be possible to network connect up to 31 controls as a secure network connection. All messages from a panel should be transmitted in both direction on the ring structure. Any wire-break or short-circuit on the ring shall not effect data transmission. The network shall be configurable so that single panels, groups of panels or all panels on the network operate the same site configured cause and effect fire plan.

The network shall also be configured to allow master control from any one of the control panels on the network. To cover longer distance repeaters or fibre optical cable and converters can be used between two panels.

The network shall be able to accommodate intruder alarm panels.
There shall be extensive diagnostic functions on the panel to be used to localise faults caused by interference or wiring. Networking shall be capable of carrying out using a data cable e.g. IBM type 1 or CAT5. The distance between each panel shall be standard 1200 meters and capable of extending up to 3000 meters using booster repeaters.

**NETWORKED LCD OPERATING PANELS / REPEATER PANELS**

The Repeat Panel shall be sited at the Rear Entrance, guard house or location where it is manned 24 hrs. It shall provide system repeat facilities to repeat all of the liquid crystal display messages as well as the common indications. Repeat panel shall be interfaced for network fire alarm control panels, designed for standardized display and operation as per DIN EN 54 part 2 and DIN VDE 0833 part 2. Installation and connection to FACP shall be via the short circuit and open circuit resistant Ethernet System network. RS 485 interface or TTY interface for connecting remote printers, and fire brigade shall be available. The repeaters shall have minimum three common relays freely programmable, monitored, potential free up to 24 VDC.

**BATTERIES:**

Batteries shall be provided and shall be the dry sealed lead-acid type. The batteries shall have ample capacity. With primary power disconnected, to operate the fire alarm system for a period of 24 hours with an optional 72 hours battery backup. Following this period of operation via batteries. The batteries shall have ample capacity to operate all components of the system, including all alarm signalling devices in the total alarm mode for a minimum period of 30 minutes.

**WIRING**

All cables associated with Fire Alarm installation shall be of fire resistant 2 core 1.5 sq. mm twisted pair. Cables shall comply with BS 6207 Part 1. The cable is to BS 6207: Part 1 having, Typically no more than 2 cores each core having 1.5 sq. mm cross sectional area, A red cover sheath (preferred for alarm applications), Having continuous metal sheath encapsulation, Fire resistant tested to BS6387 categories CWZ.

**INSTALLATIONS**

The entire fire alarm system shall be installed in accordance with DIN / BS EN54 / NFPA Standards and manufacturer’s approved shop drawings, written instructions and recommendations.

**TESTING**

Fire alarm system shall be tested in accordance to Local Civil Defence regulations and put into operation by the manufacturer or his authorized representative in the presence of engineer. Fault and alarm conditions shall be simulated and all data and alarm indicators checked with full events recorded on system printer according to the testing procedure.

**PUBLIC ADDRESS SYSTEM STANDARDS International:**

The technical design must comply with EN 54-16 for the VA/PA system.

Compliance can be verified by means of a manufacturer declaration, CPD certificate or by obtaining approval from VdS or similar certification body.

Certification according to EN 54-16 is a mandatory requirement.

With the VA/PA system provided and its additional components, it must be possible to set up a project which also conforms fully to EN 60849 requirements and which can be approved by a relevant expert or authority.

**GENERAL DESCRIPTION**
For the transmission of alarm signals in the event of a fire or other disaster, as well as for public announcements and playing music, an emergency audio warning system or a voice alarm system with self-monitoring functionality and alarm criteria should be installed in compliance with TRVB S 158, VDE 0833-4 and DIN 33403 standards.

The purpose of the system is to quickly evacuate people in an orderly manner via escape routes through the use of prepared clear text instructions. In addition, it must also be possible to for all instructions that are announced live to be sent to circuits and groups.

There must be an intercom function between the digital call stations.

The failure of an amplifier or a loudspeaker circuit should not lead to the failure of a public address area. For this reason, in addition to the backup amplifier, the loudspeaker circuit also has A/B wiring in all public areas.

In total, up to 6,000 programmable, monitored loudspeaker circuits must be available as well as up to 2,000 NF inputs (250 x 4 x 2) or 1,000 digital call stations.

Due to simultaneous program transmissions, there must be up to 120 simultaneous audio transmissions within the VA/PA system.

It must be possible to assign inputs (including digital call stations) and outputs throughout the system without any restrictions.

A graphical user interface is used for simple and convenient configuration of the combination of groups, changes in loudspeaker circuits or key assignments without the need for any mechanical modifications.

When selecting the loudspeaker systems and rating the electrical and acoustic audio frequencies, the following sound pressure levels are used:

- 90 dB in larger public areas and for fire alarm/evacuation announcements, at least 12 dB higher than the maximum anticipated ambient noise with speech intelligibility STI > 0.5.

Loudness level and speech intelligibility must correspond to all the points of the above areas where required (e.g. in the event of an alarm or rescue operation) for evacuation purposes and transmission of information.

The public address system must be designed in accordance with the following basic requirements:

- provision of direct sound to widest possible area +/- 3 dB of the relevant ranges
- high level of system reliability (at least 99% availability)
- optimal transmission quality

A fully digital, programmable, network-ready VA/PA system must be provided to ensure that the system is future-proof, flexible, and can be easily extended.

A 100 Mbit Ethernet LAN, also for proprietary use, serves as a means of transmitting signals.

It must be possible to design a redundant network by means of external modules.

It is particularly important that 100 V lines, power cords, control and modulation lines are properly isolated.

Amplifiers must have symmetrically audio inputs.

The VA/PA system must fulfill the following requirements:
• Fully digital network-capable system with graphical user interface. Operating software for remote control and diagnosis of all systems states. Software for optional setup (configuration) of functions, modes and properties of system components, devices and controls including the connection of loudspeaker lines to public address areas, and the corresponding allocation of a selection key at the system digital call station; The user can modify the configuration using any client with an easy-to-understand, menu-driven user interface. Up to 120 simultaneous audio channels must be available over the network with an available bandwidth of 100Mbit/s effective.

• Continuous, inaudible monitoring of all signal paths
• All errors must be detected, displayed, and recorded (log view) within a matter of seconds.
• Ability to easily program digital call stations for selective, group and collective calls (e.g. 1 fire control PA panel, 3 information call stations, more possible at any time).
• Continuous monitoring of power amplifiers with integrated noise detection and inaudible tone. If a power amplifier should fail, a backup amplifier will automatically and immediately replace the power amplifier in question.
• Double pole connection of 100 V loudspeaker modulation;
• Continuous processor - controlled line monitoring of all loudspeaker lines for short circuits, idling, ground faults and impedance value errors, independent of activated announcements. Monitoring must not be audible. Save error messages with the option for subsequent display; save set points of line parameters; Set up and interrogate system with easy-to-understand, menu-driven software. Non-reactive disconnection of loudspeaker circuits detected to be faulty without any consequence to any other speaker lines.
• To ensure continuous operation, the gooseneck microphone for the digital call station must be acoustically monitored. Similarly, the malfunction of any button, component, cable, or any logical connection must be monitored and sent to the operating unit immediately via the LAN. The signal is transmitted between the digital call station and the central control unit in AHO/EBU digital audio format.
• Intercom function between digital call stations.
• To adjust the volume in public address areas with constantly changing noise levels, an automatic volume control must always be available in real time, independent of the ambient noise level. This function is activated using software tools from the appropriate central output modules for this area.
• Digital storage and playback of at least 16 different alarm signals and texts for 260 seconds in non-volatile memory.
• Input of external signal sources (independent programs/background music) in the VA/PA system via separate input modules and via NF inputs in the system digital call stations.
• Connection to a fire alarm system

The planning and invitation to tender are based on Honeywell's VARIODYN D1 model. Equivalence must be ensured in the case of alternate offers as these are based on customer-specific assessments of requirements.

Special performance features

List features which can only be answered with YHO or NO, or with a value:

Performance features with YHO/NO

Audio monitoring
- All audio information can be selected locally on the VA/PA system using the monitor button and can be monitored via the integrated loudspeaker.

- The monitor function can be deactivated automatically by pressing a button or via a user-defined timeout.

Alarm mode
- The system switches to an alarm mode for alarm announcements.

- Announcements with low priority, such as background music, are stopped.

- Standard-compliant alarm signaling.

Digital signal processing (DSP)
- Per DAL bus audio stream
  * Adjustable volume
  * Configurable limiter for the digital call station microphone (DCS, DCSF).
- Per Amplifier channel
  * Adjustable volume
  * Automatic volume control (AVC)
  * High-pass filter 2, 4, 6 sequence (cutoff frequency: 20 Hz - 20 kHz)
  * Low-pass filter 2, 4, 6 sequence (cutoff frequency: 20Hz - 20kHz)
  * Delay (0-2.000 msec)
  * Parametric equalizer, 8 bands
  - Level indicator for audio inputs and outputs.

**Audio memory/signals**
- Audio memory for critical alarms such as evacuation announcements in accordance with IEC EN 60849 on non-volatile flash memory. 16 memory places for 260 sec in total are available. E.g. for pre recorded audio signals (gongs, signals, texts, etc.) for example in accordance with DIN 33404 and KTA 3901, in each digital audio distribution and connection system (maximum 24 Loudspeaker lines each)

- System wide audio memory for critical alarms such as evacuation announcements in accordance with IEC EN 60849 on non-volatile flash memory. The memory capacity is approximately 120 minutes.

- Audio memory for non security relevant announcements such as advertising texts or music on a hard drive. The memory capacity is approximately 1000 hours.

**Connection of a source to a target taking the following into account**
- Connection time limit
  - Activation type – press/toggle
  - Individual volume
  - With/without automatic volume control
  - Multisource; an audio source can be used by several connections simultaneously.
  - Priority (1-250)
  - Recording the activation or deactivation of the connection.
  - Saving the announcement
  - Partial connection
  - Timeout
  - Warning signal, e.g. an attention signal such a gong
- Reconnection

- Repetition

**Error display**
- The error message can be displayed based on the location.
- Error display either by LED or control contact and by means of an entry in the message list.
- Error messages are always reported as “OK” after the underlying cause has been rectified.
- Error messages can also be automatically reset – if necessary.
- Error messages can also be manually acknowledged by means of key(s) or contact(s).
- Potential error-specific signaling to LEDs and control outputs.
- Monitoring can be completely switched on or off at the device level for each DOM.

**Remote control, remote maintenance**
- The system can be remotely maintained via an open data protocol.

Building management systems, path control machines, or airline passenger information systems, for example, can set any individual announcements and obtain status information from the system.
- The system can be maintained remotely via ISDN, for example.

Configuration changes and read outs of all events can be performed over long distances.

**Graphical user interface.**
- A user interface customized to specific customer requirements can be implemented easily and flexibly.

**Backup amplifier**
- In the event of failure of an amplifier channel, the system automatically switches to a backup amplifier.
- The system switches to the backup amplifier dynamically. In the case of two faulty amplifiers within a group of amp’s which are connected to one backup amp, the priority of the announcement decides which amplifier is switched to the backup.

This is must be dynamically. That means no fixed backup / amp combination. If another time the priority of another not available amp is higher, this will be replaced.
- The volume from the faulty amplifier channel is transferred over.
- The ratio and the number of main to backup amplifiers can be defined by the user between 4 and 12 amplifiere channels to one backup amp

**Intercom call stations**
- Digital call station to digital call station.
- Digital call station to digital call station and other loudspeaker circuits.
- Digital call station to several digital call stations.
- Digital call station to several digital call stations and other loudspeaker circuits.

**Configuration**
- Configuration via graphical user interface.
- Parameters can be read and modified in real time.
- Certain user privileges can be allocated via user management.

**Volume control**

- Automatic volume control
  - Each amplifier channel is regulated dynamically depending on the ambient noise and taking into account predefined parameters and background music.
  - Announcements (mostly alarms/evacuations) with a certain priority can be played out on a fixed configured volume, without automatic volume control.
  - The ratio of ambient noise to changes in volume can be set individually.
  - The automatic volume control inputs for the sensor microphones can also be used as audio signal inputs, if necessary.
    - Background music must not have an influence on the automatic volume control
    - Manual volume control for all audio inputs/outputs via buttons and contacts.
    - Alarms/evacuations can be output with maximum volume per configuration
      (Manual volume control is ignored).
    - Time-based volume control for all audio inputs/outputs, e.g. reduced volume at tram stops at night.

**Message list**

- All system-related events are recorded in the message list.
  - Download of error message with a PC/Notebook.
  - “External systems”, e.g. emergency power supplies can create entries in the message list.

**Power management**

- Primary power supply: 230 V AC
- Secondary power supply (emergency power): 24 V DC
- Less important announcements (e.g. background music) can be switched off when there is an outage in the primary power supply (230V AC).

**Control inputs & control outputs**

- Keys with associated LEDs or contacts
- Any allocation of control inputs and control outputs for functions, e.g. for triggering priority relays for 100V volume controllers.

**Monitoring**

- Monitoring of connection from digital call station to VA/PA system.
  - Acoustic monitoring of digital call station microphone or hand microphone (fire control PA panel).
  - Acoustic monitoring of amplifier channel.
- Monitoring of loudspeaker line for short circuits, interruptions and impedance changes via impedance measurement – independent of connections.

The thresholds for short circuits, open lines, and ground faults can be customized.

- Monitoring of loudspeaker line for short circuits or interruptions by means of EOL (end of line module) – independent of connections.

- Monitoring of loudspeaker line for ground faults.

Independent of circuit-entering loudspeaker lines:

- Monitoring of the communication of several VA/PA systems on the network.

- Lamp tests/contact tests via button or contact.

- Error in data interface to fire panels (e.g. Honeywell, Notifier)

- Failure in primary and secondary power supply (emergency power)

**Wiring**

- Each required system can be wired quickly and clearly using only a few system cables.

**Networking**

- Up to 250 digital audio distribution and connection systems on a network.

- Networking via 10, 100 Mbit(recommended) or Gbit Ethernet.

- Transmission of various audio data is only restricted by the transmission bandwidth.

- Up to 120 audio data channels on a 100 Mbit network.

- Up to 16 different audio channels items per digital audio distribution and connection systems can be processed simultaneously over the network.

- SNMP (Simple Network Management Protocol) to monitor network elements from a central station.

- Specified delay of local destination for a connection to offset the latency period of the network destinations.

- VLAN ID can be adjusted for integration in existing network structures, e.g. taking into account other network systems such as CCTV, etc.

**Timer programs**

- Time-controlled connection for bell systems, e.g. in schools.

- Time-based volume control for all audio inputs/outputs, e.g. reduced volume at tram stops at night-time.

- Time-controlled activation/deactivation of monitoring of loudspeaker lines.

- Time-controlled actuation/deactivation of amplifier channels monitoring.

**Time synchronization**

- The individual devices are synchronized. Master/Slave configuration possible.
- External time synchronization via NTP (Network Time Protocol) possible.

- External time synchronization via GPS possible.

- Automatic adjustment for daylight saving changes.

**Destination – Group formation**
- Any circuits (destinations) can be grouped together in pre-selection points.

- Circuits can be grouped in any nested format.

**Temporary storage of an announcement (automatic)**
- Announcements can automatically saved and played back within a user-defined timeout period when the required points are released.

- Status display and control options via buttons and control contacts.

**Temporary storage of an announcement (manual)**
- Record, listen and playback possible.

**Audio matrix**
- Any input can be route to any output without any restrictions
  - Input can be a call station, analog audio input, and audio memory
  - Out put can be a loudspeaker line, call station and analog audio output

**Performance features with value indication**

Max. number of addressable audio inputs: 2,000

Max. number of audio data items that can be transmitted simultaneously via 100 Mbit Ethernet: 120

Max. number of addressable amplifier channels: 1,000

Max. number of addressable loudspeaker circuits: 6,000

**Interfaces**

**Connection to fire alarm system**

This system also allows for alarm management with prepared texts in the case of an emergency by means of an interface to the fire detection system. For this, the system must be connected to the emergency power supply, and the loudspeakers should be installed in such a way that they are fire resistant in the event of a fire escaping beyond the fire compartment (see instructions). All VA/PA systems must be approved as alarm detector systems by an authorized testing body.

Interface: RS232

Data rate: 19,200 bps

The interface is monitored continuously; in the event of a failure/interruption, an error message occurs on the VA/PA system and the fire alarm control panel. The triggering of the alarm can be defined via control zones. Any other errors that may arise, such as the failure of a power amplifier, digital call station or routing to the loudspeakers, will be forwarded to the fire alarm control panel as a trouble alarm. Trouble alarms can be reset via the fire alarm control panel. A date/time synchronization can be configured between the VA/PA system and the firm alarm control panel.
Connection to a building management system (or safety management system)

A building management system (or safety management system) and the VA/PA system must be linked by means of the relevant interfaces; mere contact connections/controls are eliminated. The system is connected to the fire detection system via the fire control settings.

With regard to the VA/PA system that is to be linked to the safety management system, the following functions at the very least must be in operation or available:

- Circuit selection (must also be possible for each available call circuit to be selected from the master computer)
- Group call (groups can be defined freely in terms of software)
- Collective call from digital voice memory
- Alarm sounds
- System synchronization (messages, time)
- Message fault VA/PA System on building management system (or safety management system) master computer
- Message fault amplifier on building management system (or safety management system) master computer
- Message fault digital call station on building management system (or safety management system) master computer
- Message fault loudspeaker on building management system (or safety management system) master computer
- Message fault call circuit (by monitoring circuits) on building management system (or safety management system) master computer

It must be possible to configure and program the VA/PA system via a PC. The software enables the loudspeaker matrix and digital call stations to be monitored and controlled remotely. A color graphic depicting all of the components to help users identify errors more effectively. The PC and the system are at least connected via a serial interface.

Products

System components

Digital audio distribution and connection system for up to 8 loudspeaker zones
Module with audio signal processing for connecting and controlling power amplifiers and for connecting loudspeaker circuits.

Four independent audio outputs for connecting power amplifiers (up to 500 Watt per channel) and for simultaneous processing of up to four different audio information items per module.

Connection of a audio signal to one or two user-defined loudspeaker zones. In total up to eight loudspeaker circuits per module. Either up to 8 loudspeaker circuits can be operated as transmission line technology or as up to 4 loops with VARIODYN D1 loop technology. Where required, the two technologies can used in combined mode via the configuration as two loops and 4 transmission lines.

Upgrade to a complex alarm/public address system through integrated LAN interfaces.

Continuous monitoring of power amplifiers by means of a 22 kHz test tone. In the event of a failure of a power amplifier, a backup amplifier will automatically and dynamically replace the faulty power amplifier. The defined loudness level is also taken into account for the backup amplifier.

Continuous inaudible monitoring of loudspeaker lines (ground faults, short circuits, interruptions, and impedance deviations with specified tolerances for each loudspeaker circuit), even in power-saving mode, independent of
activated announcements. An end of line module can also optionally be used as a line termination and the line to the EOL can be monitored.

This ensures that short-circuited loudspeaker circuits are disconnected without affecting the rest of the system.

Continuous monitoring of line and microphone of up to four connectable digital call stations or universal input modules.

All errors are detected, displayed and recorded (message list) within seconds.

Audio filters such as parametric equalizers, high and low-pass filters and delays per audio channel can be set.

For each of the four amplifier channels, there are four sensor inputs for optional, continuous and automatic volume control in real time, independent of the ambient noise level.

It is possible to monitor locally all of the input and output channels via the integrated loudspeaker and monitor button.

Eight programmable, potential-free contact outputs for controlling external components (e.g. priority relays) or for signaling various indicator states (collective fault messages).

Four Ethernet 100 Mbit/s interface connections with switch function.

Integrated TWI bus for optional connection of an additional module (e.g. time synchronization using TCM-GPS). Display for indicating operation status, errors, circuit connection, and active power-saving mode via multi-colored LEDs.

Emergency control operation during a power failure to preserve battery capacity – this means not activating background music or low-priority announcements when there is a failure in the primary power supply. The connected amplifiers are switched to stand-by mode.

Non-volatile audio memory for up to 260 seconds, freely scalable, for user-specific canned audio. Various gong and alarm signals in accordance with DIN VDE 33404, ZBV.

Emergency 24 V power supply as secondary power supply.

Display

4 LEDs for device operating state:
in operation, warning/error, emergency control option, power-saving mode

8 LEDs for indicating the control contacts state

4 LEDs for indicating the state of each of connected power amplifier

8 error and 8 loudspeaker circuit relay LEDs

Operating elements

A button for sequential monitoring local audio channels and acknowledging an acoustic error message

1 monitoring loudspeaker

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<thead>
<tr>
<th>Audio output</th>
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<tbody>
<tr>
<td>Output type</td>
<td>electronically symmetrical</td>
</tr>
<tr>
<td>Nominal level</td>
<td>0 dBu</td>
</tr>
<tr>
<td>Parameter</td>
<td>Specification</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>Max. output level</td>
<td>+6 dBu</td>
</tr>
<tr>
<td>Frequency range</td>
<td>20 Hz to 20 kHz</td>
</tr>
<tr>
<td>Max. deviation from linear frequency</td>
<td>± 1 dB in frequency range</td>
</tr>
<tr>
<td>Distortion factor at nominal level</td>
<td>&lt; 0.03% at 1 kHz</td>
</tr>
<tr>
<td>Max. distortion factor</td>
<td>0.1% in frequency range</td>
</tr>
<tr>
<td>Signal-to-noise ratio at nominal level</td>
<td>&gt;75 dB (A)</td>
</tr>
<tr>
<td></td>
<td>&gt; 70 dB</td>
</tr>
<tr>
<td>Load impedance</td>
<td>min. 5 kΩ, max. 500 pF</td>
</tr>
<tr>
<td>Sensor input (AVC*)</td>
<td></td>
</tr>
<tr>
<td>Input type</td>
<td>symmetrical, non-earthed</td>
</tr>
<tr>
<td>Nominal level</td>
<td>-51 dBu</td>
</tr>
<tr>
<td>Nominal level for emergency call station</td>
<td>0 dBu</td>
</tr>
<tr>
<td>Frequency range</td>
<td>100 Hz to 8 kHz</td>
</tr>
<tr>
<td>Max. deviation from linear frequency</td>
<td>± 6 dB in frequency range</td>
</tr>
<tr>
<td>Distortion factor at nominal level</td>
<td>&lt; 0.2% at 1 kHz</td>
</tr>
<tr>
<td>Max. distortion factor</td>
<td>1% in frequency range</td>
</tr>
<tr>
<td>Signal-to-noise ratio at nominal level</td>
<td>&gt; 65 dB (A)</td>
</tr>
<tr>
<td></td>
<td>&gt; 60 dB</td>
</tr>
<tr>
<td>Input impedance</td>
<td>typ. 200 Ohm</td>
</tr>
<tr>
<td>Control contacts</td>
<td></td>
</tr>
<tr>
<td>Max. voltage</td>
<td>100 V DC/1 A</td>
</tr>
<tr>
<td>Impulse withstand voltage</td>
<td>&gt; 2.5 kV</td>
</tr>
<tr>
<td>Pass-through contacts</td>
<td></td>
</tr>
<tr>
<td>Max. voltage</td>
<td>250 V AC, 30 V DC/5 A</td>
</tr>
<tr>
<td>Impulse withstand voltage</td>
<td>&gt; 1.5 kV</td>
</tr>
<tr>
<td>Power supply</td>
<td></td>
</tr>
<tr>
<td>Rated voltage</td>
<td>90 V AC to 264 V AC</td>
</tr>
<tr>
<td>Nominal frequency</td>
<td>47 Hz to 440 Hz</td>
</tr>
<tr>
<td>Power rating with/without 4x DAL</td>
<td>4 W/70 W at 230 V AC</td>
</tr>
<tr>
<td>Emergency power supply</td>
<td></td>
</tr>
<tr>
<td>Voltage range</td>
<td>21.6 V DC to 30 V DC</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>-5°C to +55°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>15% to 90%</td>
</tr>
</tbody>
</table>

*AVC = Automatic Volume Control

Digital audio distribution and connection system for up to 24 loudspeaker zones
Module with audio signal processing for connecting and controlling power amplifiers and for connecting loudspeaker circuits.

Four independent audio outputs for connecting power amplifiers (up to 500W per channel) and for simultaneous processing of up to four different audio information items per module.

Connection of audio signal to one or up to six user-defined loudspeaker zones for each audio output to obtain up to twenty-four loudspeaker circuits per module.

Upgrade to a complex alarm/public address system through integrated LAN interfaces.

Continuous monitoring of power amplifiers by means of a 22 kHz test tone. In the event of a failure of a power amplifier, a backup amplifier will automatically and dynamically replace the faulty power amplifier. The defined loudness level is also taken into account for the backup amplifier.
Continuous inaudible monitoring of loudspeaker lines (ground faults, short circuits, interruptions, and impedance deviations with specified tolerances for each loudspeaker circuit), even in power-saving mode, independent of activated announcements. An end of line module can also optionally be used as a line termination and the line to the EOL can be monitored.

This ensures that short-circuited loudspeaker circuits are disconnected without affecting the rest of the system.

Continuous monitoring of line and microphone of up to four connectable digital call stations or universal input modules.

All errors are detected, displayed and recorded (message list) within seconds.

Audio filters such as parametric equalizers, high and low-pass filters and delays per audio channel can be set.

For each of the four amplifier channels, there are four sensor inputs for optional, continuous and automatic volume control in real time, independent of the ambient noise level.

It is possible to monitor locally all of the input and output channels via the integrated loudspeaker and monitor button.

Eight programmable, potential-free contact outputs for controlling external components (e.g. priority relays) or for signaling various indicator states (collective fault messages).

Four Ethernet 100 Mbit/s interface connections with switch function.

Integrated TWI bus for optional connection of an additional module (e.g. time synchronization using TCM-GPS). Display for indicating operation status, errors, circuit connection, and active power-saving mode via multi-colored LEDs.

Emergency control operation during a power failure to preserve battery capacity – this means not activating background music or low-priority announcements when there is a failure in the primary power supply. The connected amplifiers are switched to stand-by mode.

Non-volatile audio memory for up to 260 seconds, freely scalable, for user-specific canned audio. Various gong and alarm signals in accordance with DIN VDE 33404, ZBV.

Emergency 24 V power supply as secondary power supply.

Display

4 LEDs for device operating state:

- in operation, warning/error, emergency control option, power-saving mode

8 LEDs for indicating the control contacts state

4 LEDs for indicating the state of each connected power amplifier

24 error and 24 loudspeaker circuit relay LEDs

Operating elements

A button for sequential monitoring of local audio channels and acknowledging an acoustic error message

1 monitoring loudspeaker
### Audio output

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output type</td>
<td>electronically symmetrical</td>
</tr>
<tr>
<td>Nominal level</td>
<td>0 dBu</td>
</tr>
<tr>
<td>Max. output level</td>
<td>+6 dBu</td>
</tr>
<tr>
<td>Frequency range</td>
<td>20 Hz to 20 kHz</td>
</tr>
<tr>
<td>Max. deviation from linear frequency</td>
<td>± 1 dB in frequency range</td>
</tr>
<tr>
<td>Distortion factor at nominal level</td>
<td>&lt; 0.03% at 1 kHz</td>
</tr>
<tr>
<td>Max. distortion factor</td>
<td>0.1% in frequency range</td>
</tr>
<tr>
<td>Signal-to-noise ratio at nominal level</td>
<td>&gt;75 dB (A)</td>
</tr>
<tr>
<td>Load impedance</td>
<td>min. 5 kΩ, max. 500 pF</td>
</tr>
</tbody>
</table>

### Sensor input (AVC*)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input type</td>
<td>symmetrical, non-earthed</td>
</tr>
<tr>
<td>Nominal level</td>
<td>-51 dBu</td>
</tr>
<tr>
<td>Nominal level for emergency call station</td>
<td>0 dBu</td>
</tr>
<tr>
<td>Frequency range</td>
<td>100 Hz to 8 kHz</td>
</tr>
<tr>
<td>Max. deviation from linear frequency</td>
<td>± 6 dB in frequency range</td>
</tr>
<tr>
<td>Distortion factor at nominal level</td>
<td>&lt; 0.2% at 1 kHz</td>
</tr>
<tr>
<td>Max. distortion factor</td>
<td>1% in frequency range</td>
</tr>
<tr>
<td>Signal-to-noise ratio at nominal level</td>
<td>&gt; 65 dB (A)</td>
</tr>
<tr>
<td>Input impedance</td>
<td>typ. 200 Ohm</td>
</tr>
</tbody>
</table>

### Control contacts

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. voltage</td>
<td>100 V DC/1 A</td>
</tr>
<tr>
<td>Impulse withstand voltage</td>
<td>&gt; 2.5 kV</td>
</tr>
</tbody>
</table>

### Pass-through contacts

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. voltage</td>
<td>250 V AC, 30 V DC/5 A</td>
</tr>
<tr>
<td>Impulse withstand voltage</td>
<td>&gt; 1.5 kV</td>
</tr>
</tbody>
</table>

### Power supply

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>90 V AC to 264 V AC</td>
</tr>
<tr>
<td>Nominal frequency</td>
<td>47 Hz to 440 Hz</td>
</tr>
<tr>
<td>Power rating with/without 4x DAL</td>
<td>50 W/80 W at 230 V AC</td>
</tr>
<tr>
<td>Emergency power supply</td>
<td></td>
</tr>
<tr>
<td>Voltage range</td>
<td>21.6 V DC to 30 V DC</td>
</tr>
</tbody>
</table>

### Ambient temperature range

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative humidity</td>
<td>-5°C to +55°C</td>
</tr>
</tbody>
</table>

### Additional messages

*AVC = Automatic Volume Control

**System communication unit**

The system communication unit acts as a digital audio memory for the VA/PA system.

This allows more than 50 channels of audio data to be recorded and played back at the same time – regardless of the available bandwidth from the network.

The connection to a VA/PA system network is established via Ethernet and is monitored continuously.

As per IEC EN 60849, the audio data for critical alarms and evacuation messages is stored on non-volatile flash memory. The memory capacity is approximately 2 hours.

Additional messages, such as announcements, signals or advertising texts, are stored on a hard drive. The memory capacity is approximately 1,000 hours.
The component can also be used for logging and recording announcements. These are stored on the hard disk and saved with the date, time and trigger information.

Including a call stacker function which allows to stored announcements temporarily and played them back simultaneously and automatically within a particular time limit when the desired point is released.

24 V DC emergency power supply as secondary power supply.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio capacity flash memory</td>
<td>approx. 2 hours</td>
</tr>
<tr>
<td>Audio capacity hard drive</td>
<td>approx. 1,000 hours</td>
</tr>
<tr>
<td>Power supply</td>
<td></td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>90 V AC to 264 V AC</td>
</tr>
<tr>
<td>Nominal frequency</td>
<td>47 Hz to 63 Hz</td>
</tr>
<tr>
<td>Nominal current</td>
<td>typ. 0.5 A @ 230 V AC</td>
</tr>
<tr>
<td>Emergency power supply</td>
<td></td>
</tr>
<tr>
<td>Voltage range</td>
<td>21.6 V DC to 30 V DC</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>-5°C to +55°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>15% to 90%</td>
</tr>
</tbody>
</table>

**Digital call station with 12 keys**

Fully digital call station with electret microphone (cardioids characteristic) on a flexible 300 mm long gooseneck.

Integrated broadband loudspeaker for monitoring and previewing purposes as well as intercom functions.

Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule.

12 freely programmable buttons, which can be labeled.

13 integrated and 12 freely programmable LED display elements including a combined operation and error display.

Digital transmission of control signals and all four audio signals to and from the digital call station and the supply voltage via DAL link.

The digital call station is connected to the VA/PA system in star-shaped topology via CAT 5E cable (shielded) and RJ45 socket (up to 300 meters distance).

Optional fiber optic connection for distances up to 2,000 meters.

RJ12 socket for connection with up to 6 expansion modules via daisy chain.

An audio input with 2 cinch sockets at the back of the digital call station for connecting an auxiliary device allows audio playback outside of the central control unit.

An audio output can be used for monitoring purposes or for audio distribution or recording.

In- and output are independent from the microphone and can be used simultaneously

A 3 m long CAT5 standard connection cable for copper cabling is included as standard.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microphone</td>
<td>electret, cardioids characteristic</td>
</tr>
<tr>
<td>Gooseneck</td>
<td>300 mm</td>
</tr>
<tr>
<td>Frequency range</td>
<td>100-15,000 Hz</td>
</tr>
<tr>
<td>Loudspeaker - power</td>
<td>1 W</td>
</tr>
<tr>
<td>Audio input</td>
<td></td>
</tr>
</tbody>
</table>
Nominal level 0 dBu
Max. level +6 dBu
Frequency range 20 Hz to 22 kHz
Signal-to-noise ratio > 95 dB
Distortion factor (at nominal level) < 0.1 %
Audio output
Nominal level 0 dBu
Frequency range 20 Hz to 22 kHz
Signal-to-noise ratio > 85 dB
Distortion factor (at nominal level) < 0.1 %
Output impedance 180 Ohm
Sample rate 48 kHz
AD/DA converter 24 Bit
Max. power consumption 150 mA
Ambient temperature range -5 °C to +55 °C
Relative humidity 15% to 90%

**Digital call station with one key**

Fully digital call station with electret microphone (cardioid characteristic) on a flexible 300 mm long gooseneck.

Integrated broadband loudspeaker for monitoring and previewing purposes as well as intercom functions.

Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule.

A freely programmable button, which can be labeled.

Two integrated and one freely programmable LED display elements including a combined operation and error display.

Digital transmission of control signals and all four audio signals to and from the digital call station and the supply voltage via DAL link.

The digital call station is connected to the VA/PA system in star-shaped topology via CAT 5 cable and RJ45 socket (up to 300 meters distance).

Optional fiber optic connection for distances up to 2,000 meters.

RJ12 socket for connection with up to 6 expansion modules via daisy chain.

A 3 m long CAT5 standard connection cable for copper cabling is included as standard.

Microphone electret, cardioid characteristic
Gooseneck 300 mm
Frequency range 100-15,000 Hz
Loudspeaker - power 1 W
Sample rate 48 kHz
AD/DA converter 24 Bit
Max. power consumption 150 mA
Ambient temperature range -5 °C to +55 °C
Relative humidity 15% to 90%
Fire Control PA Panel with 12 keys
Fully digital call station with handheld microphone and built-in loudspeaker for monitoring and previewing purposes and intercom functions in integrated housing.

Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule.

12 freely programmable buttons, which can be labeled.

12 integrated and freely programmable LED display elements including a combined operation and error display.

Digital transmission of control signals and all audio signals to and from the digital call station and to the supply voltage via DAL link.

The digital call station is connected to the VA/PA system in star-shaped topology via CAT 5 cable and RJ45 socket (up to 300 meters distance).

Optional fiber optic connection for distances up to 2,000 meters.

RJ12 socket for connection with up to 6 expansion modules via daisy chain.

A 3 m long CAT5 standard connection cable for copper cabling is included as standard.

<table>
<thead>
<tr>
<th>Microphone</th>
<th>Handheld microphone, cardioid characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>200-12,500 Hz</td>
</tr>
<tr>
<td>Loudspeaker - power</td>
<td>1 W</td>
</tr>
<tr>
<td>Sample rate</td>
<td>48 kHz</td>
</tr>
<tr>
<td>AD/DA converter</td>
<td>24 Bit</td>
</tr>
<tr>
<td>Max. power consumption</td>
<td>150 mA</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>-5 °C to +55 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>15% to 90%</td>
</tr>
</tbody>
</table>

Fire Control PA Panel with one key
Fully digital call station with handheld microphone and built-in loudspeaker for monitoring and previewing purposes and intercom functions in integrated housing.

Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule.

A freely programmable button, which can be labeled.

Two integrated and one freely programmable LED display elements including a combined operation and error display.

Digital transmission of control signals and all audio signals to and from the digital call station and to the supply voltage via DAL link.

The digital call station is connected to the VA/PA system in star-shaped topology via CAT 5 cable and RJ45 socket (up to 300 meters distance).

Optional fiber optic connection for distances up to 2,000 meters.

RJ12 socket for connection with up to 6 expansion modules via daisy chain.

A 3 m long CAT5 standard connection cable for copper cabling is included as standard.
Frequency range 200-12,500 Hz
Loudspeaker - power 1 W
Sample rate 48 kHz
AD/DA converter 24 Bit
Max. power consumption 150 mA

Ambient temperature range -5 °C to +55 °C
Relative humidity 15% to 90%

**Digital fire control PA panel**

- Fully digital call station with handheld microphone and built-in loudspeaker for monitoring and previewing purposes and intercom functions in surface-mounted or flush-mounted housing.

- Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule.

- Five freely programmable buttons for the alarm

- One button for the all-clear signal

- One button for reset/acoustic

- Three integrated LED display elements (in operation, fault, busy)

- Digital transmission of control signals and all audio signals to and from the digital call station and the supply voltage via DAL link.

- The digital call station is connected to the VA/PA system in star-shaped topology via CAT 5 cable and RJ45 socket (up to 300 meters distance).

- Optional fiber optic connection for distances up to 2,000 meters.

- Display window and locking mechanism in accordance with EN 54-11.

- Conforms to the Austrian F 3033 standards and must be verified by a positive test protocol carried out by an accredited body.

  | Microphone | Handheld microphone, cardioid characteristic |
  | Frequency range | 200-12,500 Hz |
  | Loudspeaker - power | 1 W |
  | Sample rate | 48 kHz |
  | AD/DA converter | 24 Bit |
  | Max. power consumption | 150 mA |
  | Ambient temperature range | -5 °C to +55 °C |
  | Relative humidity | 15% to 90% |
  | Color | Red RAL 3000 |
  | Weight | approx. 2.0 kg |
  | Dimensions (H x W x D) | 300 x 200 x 30 mm |

**Digital Keyboard Module**

- Digital keyboard module for digital call stations

- Allows an extension of 18 extra freely programmable keys that can be labeled as well as 18 LED display elements.

- Digital transmission of control signals to the digital call station.
The keyboard module is supplied with 24 V DC by the digital call station.

Ambient temperature range  
-5 °C to +55 °C

Relative humidity  
15% to 90%

**Universal Interface Module**
Interface module for connecting two analog audio inputs, two analog audio outputs, and 48 control contacts.

The two audio inputs are both asymmetrical (RCA) and symmetrical (XLR-f).

The two audio outputs are both asymmetrical (RCA) and symmetrical (XLR-m).

The 48 control contacts can be set via software configurations in any combination as potential input contacts and/or output contacts; eight can be monitored.

Digital transmission of control signals and all audio signals to and from the VA/PA system and the supply voltage via DAL link.

**Display**

A green POWER LED

A yellow ERROR LED

4 green SIGNAL LEDs for signaling potential audio modulation.

**Audio inputs**
- **Nominal level**: 0 dBu
- **Max. level**: +6 dBu
- **Frequency range**: 20 Hz to 22 kHz
- **Signal-to-noise ratio**: > 95 dB
- **Distortion factor (at nominal level)**: < 0.05 %
- **Input impedance XLR socket**: 100 kΩ, symmetrical, potential-free
- **Output impedance CINCH socket**: 1 kΩ, asymmetrical, potential-free

**Audio outputs**
- **Nominal level**: 0 dBu
- **Frequency range**: 20 Hz to 22 kHz
- **Signal-to-noise ratio**: > 85 dB
- **Distortion factor (at nominal level)**: < 0.05 %
- **Output impedance XLR socket**: 200 Ω, symmetrical, potential-free
- **Output impedance CINCH socket**: 200 Ω, asymmetrical, potential-free

**Control contacts**
- **Input contact**
  - Max. input voltage: +36 V DC

**Output contact**
- **Contact rating**: 36 V DC/50 mA
- **Short-circuit proof for +24V**: 1 s

Ambient temperature range  
-5 °C to +55 °C

Relative humidity  
15% to 90%

**Contact Interface Module**
Interface module for connecting eight control contacts.
The eight control contacts can be set via software configurations in any combination as potential input contacts and/or output contacts; four can be monitored.

Digital transmission of control signals and the supply voltage via TWI (two-wire interface).

Control contacts
Input contact
Max. input voltage +36 V DC
Output contact
Contact rating 36 V DC/50 mA
Short-circuit proof for +24V 1 s
Ambient temperature range -5 °C to +55 °C
Relative humidity 15% to 90%

Power amplifier 2 x 250 W/100 V; class D, 24 V DC
Highly efficient class D power amplifier.

The power amplifier includes the following characteristics:
- Complies with IEC BS EN 60268-3, 55013, and 55020 standards
- Self-monitoring and self-testing via microcontrollers
- Protected against overload, short circuits and over-heating
- Built-in fan with temperature-controlled rotation speed control, with airflow from front to back of device
- Monitoring of the fan’s t self, if one is failed – the left fan must set on 100% speed automatically.
- LED status display per channel for POWER, SIGNAL, CLIP, and ERROR
- LED status display for MAINS POWER; BATT POWER, CPU STATUS, SYS FAULT
- Emergency power supply via 24 V DC
- Symmetrical audio inputs and control via CAT 5 cable with RJ45 connector
- 100 V outputs via pre-assembled system cable, lockable

Technology
Output power (at 230 V mains supply) 250 W with 40 Ω load
Output power (at 24 V DC emergency power supply) 250 W with 40 Ω load
Mains supply 230 V AC 50/60Hz +10% to -15%
Emergency power supply 21.5 V DC to 28.5 V DC

Frequency response 50 Hz to 22 kHz ± 3dB
Distortion factor < 0.3% at 1 kHz sine
Signal-to-noise ratio 90 dB (A-weighted)
Channel separation > 75 dB
Efficiency at maximum power > 80%

Color RAL 7016
Ambient temperature range -5 °C to +55 °C
Relative humidity up to 90 % (non-condensing)
Power amplifier 2 x 400 W/100 V; class D, 24 V DC

Highly efficient class D power amplifier.

The power amplifier includes the following characteristics:

- Complies with IEC BS EN 60268-3, 55013, and 55020 standards
- Self-monitoring and self-testing via microcontrollers
- Protected against overload, short circuits and over-heating
- Built-infan with temperature-controlled rotation speed control, with airflow from front to back of device
- Monitoring of the fan’s t self, if one is failed – the left fan must set on 100% speed automatically.
- LED status display per channel for POWER, SIGNAL, CLIP, and ERROR
- LED status display for MAINS POWER; BATT POWER, CPU STATUS, SYS FAULT
- Emergency power supply via 24 V DC
- Symmetrical audio inputs and control via CAT 5 cable with RJ45 connector
- 100 V outputs via pre-assembled system cable, lockable

<table>
<thead>
<tr>
<th>Technology</th>
<th>Class D, 100 V outputs with transformers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output power (at 230 V mains supply)</td>
<td>400 W with 25 Ω load</td>
</tr>
<tr>
<td>Output power (at 24 V DC emergency power supply)</td>
<td>400 W with 25 Ω load</td>
</tr>
<tr>
<td>Mains supply</td>
<td>230 V AC 50/60Hz +10% to -15%</td>
</tr>
<tr>
<td>Emergency power supply</td>
<td>21.5 V DC to 28.5 V DC</td>
</tr>
<tr>
<td>Frequency response</td>
<td>50 Hz to 22 kHz ± 3dB</td>
</tr>
<tr>
<td>Distortion factor</td>
<td>&lt; 0.3% at 1 kHz sine</td>
</tr>
<tr>
<td>Signal-to-noise ratio</td>
<td>90 dB (A-weighted)</td>
</tr>
<tr>
<td>Channel separation</td>
<td>&gt; 75 dB</td>
</tr>
<tr>
<td>Efficiency at maximum power</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Color</td>
<td>RAL 7016</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>-5 °C to +55 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>up to 90 % (non-condensing)</td>
</tr>
</tbody>
</table>
**Loudspeaker** Ceiling Loudspeaker

<table>
<thead>
<tr>
<th>Specifications</th>
<th>SS-CL06</th>
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<tr>
<td>Rated Power</td>
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<td>Input Impedance</td>
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<td>3 W, 1.5 W, 0.75 W</td>
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<tr>
<td>Power taps @100V</td>
<td>6 W, 3 W, 1.5 W</td>
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Wall Mount Loudspeaker

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</table>

**UPS SYSTEM - SYSTEM COMPONENTS**

PWM IGBT with high frequency (25 KHz or more) or better Technology.

**POWER**

On-Line UPS with upgradability minimum 50% (specify the limit, process and cost implication for expanding the power rating).

**PRODUCT CERTIFICATION/TESTING**

The product shall have certification from any one of the following -

a) ERTL
b) ETDC
C) STQC
d) IEC
e) ISO 9001

**OPERATING TEMPERATURE**

0-40 degree Centigrade
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**HUMIDITY**

Upto 95%

**OUTPUT FREQUENCY**

50 Hz +/- 0.01% Hz

**WAVE FORM**

Pure Sine Wave

**TRANSIENT RESPONSE**

 +/- 1% maximum under following conditions:

a) Loss or Return of Input AC supply

b) 100% step load

**RECOVERY TIME**

To nominal voltage in less than 10 milli second.

**EFFICIENCY (OVERALL)**

Minimum 95% at full load.

**LOAD POWER FACTOR**

0.8 lag to unity.

**CREST FACTOR**

Greater than 3:1

**MTBF**

Minimum 100000 hrs.

**SWITCH OVER TIME**

Zero

**OVERLOAD RATING**

110% for 30 minutes
125% for 10 minutes

200% for 1 minute

**NOISE**

Less than 65 dB at 1 mtr.

**SWITCHING SPEED**

Minimum 2 KHZ

**INDICATION**

Mains ON/OFF, Battery HIGH/LOW, Battery ON, Invertor ON/TRIP, O/P HIGH/LOW, Battery HIGH/LOW, Alarm for Battery Discharge.

**PROTECTION**

Input - Over/Under voltage, Over Current.

Battery - Over/Under Voltage, Over Current, Battery Low Alarm/Trip.

Output - Over/Under Voltage, Over Current.

Output - Short Circuit Over Temperature DC Over Current

**CONTROL CIRCUITORY**

Microprocessor based control circuitry be provided and all indications will be digitally displayed using microprocessor based software.

**METERING**

Digital display with multifunctional key panel indicates.

Output Voltage/Current

DC Voltage/Current

Output Frequency

**COMMUNICATION PORT**

RS 232

**DIAGNOSIS & CONFIGURATION SOFTWARE**

Compatible with Unix/Windows.

**OUT LOOK**
COMPACT SIZE WITH AESTHETICALLY GOOD LOOK (SPECIFY THE SIZE AND WEIGHT)

BATTERY

Lead Acid, S.M.F. for 20 minutes/1 Hr back-up under full load. Battery sizing calculations to be submitted. Make of batteries shall be Panasonic or Global Yuasa.

UPS FAILURE

During failure in the UPS equipment the static switch automatically transfer the A.C. load directly to the AC. line in less than 1/4 cycle so that transfer does not affect critical equipment operation.

HARMONIC DISTORTION OF WAVE FORM

Total harmonic distortion (THD) should be below 2% for linear load and below 3% for nonlinear load.

MAINTENANCE BY PASS SWITCH
The portion of UPS module used to connect the alternator supply to critical load while electrically isolating static switch and inverter for maintenance purpose.

BATTERY DISCONNECT SWITCH
The switch used to electrically isolate the storage batteries from UPS module.

STATIC TRANSFORMER SWITCH
The switch senses an inverter shutdown signal or degradation of inverter output item. It shall automatically transfer the loads from one inverter to the alternative AC power without interruption.

RETRANSFER TO INVERTOR
The static transfer switch shall be capable of automatically retransferring the load back to inverter after the inverter has returned to normal voltage and stabilized for period of time.

QUALITY ASSURANCE
The manufacturer shall have quality assurance program with check on incoming parts and final products. A final test procedure for product shall include a check of all performance specifications and a minimum 24 hour running.

INSTALLATION DRAWING
After the receipt of order a minimum two sets of installation drawings showing outline dimension, weights and connections and a one line drawing of the UPS shall be sent to the purchaser to be used in planning the installation of the system.

PRODUCT DOCUMENTATION
Manufacturer shall supply a comprehensive set of product documentation for:

1. Installation
2. Operation
3. Maintenance

This should include complete outline and external connection drawings and schematic and physical wiring diagrams as well as parts list and parts layout down to the smallest components level. It should include startup and service manuals with complete privation and remedial maintenance and trouble showing instructions. This should include all ancillary equipment and accessories.
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TRAINING

It is important that at least 2 personnel who are to be responsible for operation and maintenance of UPS be trained at the manufacturer site.

SPARE PARTS

The recommended spare parts for 5 years of maintenance are to be listed and should be quoted along with main modules.

MATERIAL AND WORKMANSHIP

1) Workmanship shall be first class in every respect.
2) All material shall be new and of best commercial grade.
3) Brackets and securing hardware shall be electroplated with corrosion resistance material.
4) Internal wiring conductors shall be combined into cable or bundles and shall be tied securely together and numbered or coded to correspond with documentation.

STORAGE BATTERY

The storage battery shall be furnished with racks connecting hardware and standard service resistance material accessories. The battery shall be delivered charged and filled ready for service.

SERVICE REPORT

Assigned field service report describing start-up and on site testing shall be furnished.

MAINTENANCE

If the battery is taken out of service for maintenance by manually opening battery disconnect switch the UPS shall continue to function and meet all the performance criteria specified except.

INVERTOR EFFICIENCY

96% minimum

PROTECTION CLASS

IP – 20

EPABX SYSTEM-

The bidder must be an OEM OR JV partner with the OEM with 25% equity participation OR Bidder should produce an undertaking from OEM in the name of client that the bidder is authorized to quote and will provide support & spares directly or indirectly for the offered system for the next 10 years. Further the OEM should also state that the offered system is latest system being manufactured by it.

The bidder must provide a list of customers with complete contact numbers, contact person name where they have commissioned similar type of EPABX.

The bidder should be able to demonstrate advance features/ solutions (those have been complied/ claimed) running in their system in this region on short notice. Features include (QSIG, IP telephony, remote shelf etc).

Valid TEC Approval for IP PBX under TEC specification number IR/PPX/-01/02. DEC’2004(IP PBX for Private use) for the Make & model quoted should be submitted along with offer for, TEC should be for 12000 IP users.
Offered exchange should be field proven & reputed make. Brand should be in India for at least 10 Years. Necessary documentation to this regard must be submitted.

The offered exchange of should have been interfaced to BSNL/ MTNL in atleast 3 locations & should have been working satisfactorily. Details of executing similar type of works shall be furnished as per attached schedule.

Bidders to submit latest ITCC, STCC & Annual Report duly certified.

The OEM should be a member of ECMA and IPNS. Test Certificates with other make exchanges certifying demo of QSIG should be attached.

Any Government body in India should not have blacklist the bidder or it’s subsidiary, dealing in similar products.

The firm should have adequate financial stability & status to meet the financial obligations of the scope of work & have a turnover of at least 15 crores from the same business during last 3 years. The bidder should submit their Profit & loss statements for the last three years.

TECHNICAL SPECIFICATIONS FOR EPABX SYSTEM

GENERAL

The specifications mentioned in the tender document are intended for the EPABX system.

EXCHANGE SPECIFICATIONS

The proposed IP EPABX system should be 100% Non-blocking switching system with ISDN/ATM compatibility. (Integrated Services Digital Network/Asynchronous Transfer Mode), configured for - Analog Extensions with CLIP, - Digital Extensions, - P&T Lines, expandable up to 10,000 Extensions.

The system should support A as well as mu law and support following compression standards on audio


Valid TEC Approval for the Make & model quoted in the name of the bidder should be submitted along with offer for: TEC should be for 12000 IP users.

The proposed IP EPABX switching technique should be confirming to latest ITU-T and CCITT standards. The EPABX should function in hot-standby duplicated configuration for all control cards and ringer section.

The system should provide complete Non-blocking digital path for Voice and Data Communication (IP Protocol). The system should also offer an in built Ethernet port management.

SYSTEM ARCHITECTURE

The offered system should be modular in design. The architecture of the EPABX should be capable of seamless migration to its maximum capacity by simply adding peripheral cards on the same set of control cards & CPU without compromising on any function /features of this system or any degradation of service.

The proposed system should follow the principle of convergence and accordingly the control should in CPCI architecture.

The system topology should be fully duplicated in terms of time slot, tone, clock highways power supply and processor. It should be based on decentralized control.

The EPABX should support linking of Homogeneous EPABX over IP with full feature transparency (distributed architecture) & IP Remote Shelf (Access points). IP Access points should be centrally administrable from the host system. Adequate details shall be furnished.

Distributed switching should be possible on IP Access points (IP Remote Shelf) also.
The system should have Universal ports for line/trunk cards. Wherein any peripheral card can be inserted in any slot of the peripheral shelf, thereby enhancing the flexibility of the configuration.

CENTRAL PROCESSING UNIT

The Central Processing Unit of the EPABX should be a 32 Bit Hierarchical Pentium based microprocessor with fully distributed controls, offering hot standby configuration with transparent switchover without disconnection of calls on occurrence of fault, covering all control cards etc.

The processed system should have the ability of Busy Hour Call Attempt (BHCA) of above 200000.

STORAGE MEDIA

The system should provide world’s latest technique of storage media (Flash EPROM or Magnetic Optical disk for higher reliability and fast booting). Please mention the storage media used for Main Memory & standby memory.

TRUNKS

ISDN (INTEGRATED SERVICES DIGITAL NETWORK): The offered exchange should be an ISDN ready switch. The system platform should be ready for ISDN and only the necessary ISDN BRI & PRI cards (Basic Rate Interface & Primary Rate Interface) need to be added for functionality (Please refer to Bill of Quantity if the requisite cards are required at present).

The system should be capable of accepting different types of signals for E1, ISDN (BRI & PRI), Ring down, 2W/4W E&M signaling etc.

The system should support E1 (30 channel PCM) level DID.

The system should have IP trunks on H.323 standards as well as SIP trunks. SIP should be supported on standard RFC3261. The system should provide SIP subscribers and SIP trunks on the same interface

The system should support E1 & PRI on the same card. These cards should have dual (2x30 channel) modularity.

The digital card should directly take on monomode/multimode fiber on the E1 interface without use of any external device such as Optimux. External fiber interface to system shall not be acceptable.

DUPPLICATION

System Redundancy: The system should be provided with 100% Duplicated Control Unit in Hot standby mode. The following Duplication should be provided with the system for:

Common Control
Switching Network
Tones
Main and standby memory

Redundancy: The system should provide complete set of control cards duplication. In case of failure of one processor card the duplicated card should take over immediately with the current database, on which the system is working, without the disconnection of established calls.

The offered system should be capable of Hot Swapping of all cards without switching off the system where the necessary cards can be interchanged or replaced even in online conditions.

It should be possible to reach the ultimate capacity (10000 ports) of the switch without any upgradation of the CPU & need of additional CPU’s.

OPERATING SYSTEM
The operating system of the EPABX should be UNIX based and protected against loss/alteration of memory due to power failure/unauthorized command or due to any other faulty condition.

**REMOTE SHELF**

Remote shelf should be supported on Optical Fiber.
A single remote shelf should support 256 channels between the main system & single remote shelf, on Optical Fiber cable.
Remote Shelf’s should also be supported on IP.
IP remote shelf’s should be available in 19” rack mountable shelf.
High voice quality for IP-based access points based on mechanism such as Echo cancellation, Voice Compression G.729A with 8 kbps, and Silence Suppression, Quality of Service Support via IP Network by traffic prioritization: IEEE 802.1 d/q and IETF DiffServ.
Remote shelf’s should be centrally administrable from the host system.

**HIGH QUALITY SIGNALING**

The system should provide high quality signaling earth (less than 2 ohms).

**CTI APPLICATIONS**

The offered system should support Computer Supported Telephone Applications (CSTA) in order to facilitate integration of LAN and IVRS.
The offered system should support CTI applications (Computer Telephony Integration) for features like Screen Popup through CLI or DNIS (Dialed Number Identification Service).
CTI should support for all 3rd party CTI solutions Call Path SeRver/2 CallPath Server 6000, CallPath SeRver/2 CallPath Server 6000, Microsoft client/server TAPI, Novell TSAPI.

**VOICE MAIL**

The PC based voice mail should be the same make as that of the PBX system. No external third party voice mail will be accepted. The offered voice mail system should be capable of integrating with the existing LAN/WAN and upgradable to unified communication solution (Integration of Voice mail / Fax mail / video conferencing / web conferencing etc to name a few). Users should be able to access the system internally or remotely from any phone & should be able to record standard/ personal greetings within the mailbox. The system should be able to inform the outside caller about the exact status of the desired extension (no answer/ busy). The System should also support recording of name and personalized greeting within each mailbox. System administration should be user friendly and the system should be windows based. The application development tool, which allows call flow transaction to be written & modified at site using simple menu driven command. The on line updating, changes / modification in application should be dynamically loaded/ assigned without switching off or disturbing the services.

**CONFERENCE**

It should be possible for extensions users up to maximum of 8 users with any combination of internal stations and also Tie Lines to talk to each other at the same time on the conference circuit. The conference call may be facility-actuated by one of the extension users or by any attendant. Multiple 8 party conferences should be supported. Minimum 100 conferencing circuits should be available in the quoted price.

10/100 MBPS LAN Connectivity: The system should support a 10 Mbps LAN connectivity, which is to be used for maintenance configuration of the exchange.

**ATM.** The system should support Asynchronous Transfer Mode (ATM) by the addition of a card which resides into the system. It should be possible to use for ATM networking i.e. the implementation of PBX networks via ATM Permanent Virtual Connections (PVC) and/or ATM Switched Virtual Connections (SVC). Details of ATM card available should be furnished. The system should support UNI 4.0

**Voice Over IP.** The system should support voice over IP (VOIP) applications with additional hardware. The system should support integrated in built IP Gateway. Is it possible to connect IP Phones/ soft phones to the offered EPABX on H.323 standard as well as SIP

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**CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA**

Page 417
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

**Loop Resistance:** The offered system should support loop resistance for subscriber’s 1700 ohms excluding telephone sets.

**Music On Hold:** The system should support inbuilt music on Hold. It should also be able to Interface with an external Music system i.e. CD Player etc.
The system should have Emergency transfer to predefined CO lines in case of power failure.

**PAGING & CELLULAR SYSTEM**
The offered system should support integrated DECT solution. Further the system should be capable of integrating with captive and public paging systems.

**NETWORKING**
The offered system should work under the internationally recognized Networking protocol, QSIG. The OEM should be the member of ITSI and ECMA and IPNS forum. This is must. Bidder should also submit the required documents in support of the above qualifying criteria. Bidder should also submit documents pertaining to interworking with other exchanges.

The offered system will be equipped with a external call metering facility, fully integrated with the system.

The system should be capable of integrating with DOT approved CEPT (2MBPS) cards of Direct Inward Dialing and also for connectivity with other exchanges.

Vender should include the cost of QSIG software in the system price.

The system should support the following minimum signaling & interfaces like E&M, 2 MB CEPT, R2MFC (Digital, Analog), ISDN BRI/ PRI, TSAPI, TAPI, IP Trunking, IP Gateway, ATM, LD & QSIG etc.

**DECT:** The IP PBX system should support DECT (Digital Enhanced Cordless Telephony).

**OPERATOR CONSOLE:** IP PC based operator console maximum no of IP PC Based operator Consoles should be 16.

IP PBX should have BLF (Busy Lamp Field) for ease of operation which will increase the efficiency of the operators.

IP PBX should have directory for user data base.

**MAINTENANCE CONSOLE**
The offered system should be provided with a PC based and software up-gradable maintenance console.

The system should be provided with a maintenance panel for command input and status display.

The system should have the compatibility to connect an external PC for maintenance programming.

The visual indications of the faults should be available at the Maintenance Console in terms of messages.

The system should support remote fault diagnosis up to card level.

Call statistic reports as required by the user should be available on the monitor as well as printouts. The formats of printouts should be programmable.

**DIAGNOSTIC AND MAINTENANCE FACILITY**
The system should have in built diagnostic features such as Isolation/detection of Faulty line/junction and restoration of faulty lines/junctions after rectification.
The offered system should have remote maintenance facility using dial up connection for remote maintenance with proper password protections.

It should be possible to maintain the system over LAN.

The EPABX should have auto restart capability to automatically reload the system software after system power is restored to it.

The system should have on line tracing facility on ISDN interface.

**PC for Voice Mail, Maintenance Console & Call Billing and Operator Console.** (With Original Windows):
- Intel Core Duo ,
- HDD – 80 Gb
- RAM- 1 GB
- 52 X CD ROM with Multimedia
- Keyboard
- Mouse
- 17” TFT Colour Monitor
- Speakers
- 4 no’s of PC required

**SUBSCRIBERS FACILITIES**

The system should have the capability for tracing malicious calls.

The system should offer two way splitting of calls.

The system should provide the facility of 3 party conferences. In addition, the system should have the provision of multiple 8 party simultaneous conferences involving any kind of trunk or extension.

The offered system should have the capability of assigning to each extension a variety of specified services. Further Class of service restriction should be available to the subscribers.

Call forwarding should be available in the offered system.

The offered system should provide one no service so that the calls are always attended.

The system should support abbreviated dialing system for at least 100 numbers.

The offered system should also support multiple individual dialing groups as abbreviated dialing system.

The system should be capable of allowing the users to access all the facilities from any extension of the EPABX.

The system should allow user to assign passwords to their phones to prevent misuse of subscribers facilities provided.

Discriminative Ringing for extension calls, trunk calls, Special feature calls etc should be available

Least Call Routing through alternate public networks on different time of day basis.

Night Service: When Night service is activated the operator calls should be routed to predefined answering positions.

The offered system should have the following other features for the subscribers as below:

- Line lockout
- Hot line
- Attendant recall
- Call forwarding preset/busy/no answer
- Call hunting
- Howler tone
- Automatic call back
Call waiting
Station camp on ringing
Hunting method change for each type of calls
Recorder tone
DND (Do Not Disturb)
DNDO (Do Not Disturb Override)
Variable presentable time out for Co line, Trunk lines
Tie lines
Consultation hold
Call pick up
Call parking and retrieve
Extension grouping/intercom barring
Fixed and delayed call forwarding
Storage of last number dialed
Discriminative Ringing
Moving class of Service
Group to Group restriction

POWER SUPPLY

Power Consumption of the exchange at full traffic conditions should be as low as possible. Bidders shall specify the power consumption in their offer.
A SMPS based Float cum Boost charger (FCBC) of suitable rating should be supplied, to provide the required voltage from the AC supply to the EPABX.

The offered system should be provided with maintenance free sealed batteries which can give a backup for a minimum of 04 hours.

The system should be provided with supervisory alarms for the mains failure.
Adequate protection should be provided for the system against fire & electric shocks.

The system should have an operating voltage 48 volts DC.

HIGH QUALITY EARTH

The resistance for the system should be limited to under 2 ohms.

The system should be provided with the necessary lightning protection as per ITU recommendations.

LIFE CYCLE

The offered exchange should have a life cycle of 10 years at least. Letter from OEM should be enclosed.

OPERATING AMBIENT CONDITIONS:
The offered system will be able to operate in ambient temperature range +5 to +45 degrees Celsius.

The system should be able to operate in relative humidity of about 30-80%.

Push Button Telephones with CLI facility
10 repertory Keys
Last Number Redial
Hands free duplex
Ringer, volume adjustable (high, low), Mute
Without external power or batteries
Pulse or tone dialing, temporary switch over possible
Recall key (2 flash times switchable)
Hearing aid compatibility conforming to CCITT P

Digital Phones: The digital Phones should have the following features
06 Line display
USB port for CTI interface
Fully duplex
Menu Navigating Keys
Min 06 Programmable
Adapter position for ISDN/ Analog Phone/ digital phone Interface
Support for Master slave configuration
Caller name display
Time display
Automatic Call back
Adapters that should be supported: ISDN/ Analog/ digital

Call Billing Software: The system should come along with a windows based call billing software which supports detailed call information on all outgoing & incoming calls on trunks/ trunk groups, extensions. The records should be flexible to allow customization.

IP Phone
2 x 24 Character Tiltable Display for TYPE -1 & 06 line display for TYPE -2
Control keys
Navigator for Interactive user prompts
Handsfree Operation with at least 07 fixed function keys
Support for H.323 standards and SIP
Support for Audio Codecs G.711 & G.723.1
Support for Quality of Service
Support Security H.235 protocol at the work point level
Support Power over LAN + 2 port-Mini Switch -> „One wire to the desk“
LIFT
SHOP DRAWING:

On the award of the work, the Contractor shall immediately proceed with the preparation of detailed working drawings showing the detail of each equipment that are to be installed and the associated works that are to be carried out. All the works are deemed to be included in various items of bill of quantities as applicable.

Three sets of all such working drawings duly signed by the head of the planning & design department of the tenderer shall be submitted to the consultants / Engineer-in-charge for approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. All the drawings shall be received by the Consultants/ Engineer-in-charge for approval within 04 (Four) weeks from the date of award of work. The approval of the drawings by the Consultants / Engineer-in-charge shall in no way relieve the Contractor from his obligations to provide a complete and satisfactory plant installation, testing and commissioning as per intent and purpose as laid down in the specifications.

Any omissions and / or errors shall be made good or rectified whether or not the drawings are approved. Contractor shall obtain written approval for samples as cable tray, cable tag, and other materials before placing the order.

The Contractor shall also fix operation schedule chart, in the Operating / Maintenance Room, neatly typed and framed, instructions in details, for the starting and running of the electrical equipment.

AS BUILT DRAWING:

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit three (04) sets to the Engineer-in-charge, layout drawing drawn at appropriate scale indicating the complete Electrical System “as installed”.

INSTRUCTION/MAINTENANCE MANUAL:

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for use, operation and the maintenance of the supplied equipment and installations, and submit to the Engineer-in-charge in three copies at the time of handing over. The manual shall generally consist of the following:

a)  Description of the Project.
b)  Operating instructions.
c)  Maintenance instructions including procedures for preventive maintenance.
d)  Manufacturers catalog.
e)  Spare parts list.
f)  Trouble shooting charts.
g)  Drawings.
h)  Type and routine test certificates of major items.
i)  One (1) set of reproducible ‘as built’ drawings.

LIFT:

General:

The lifts shall be A.C. variable voltage variable frequency micro processor controlled machine room.

Size & Speed:

Passenger Lifts - 13 Pax – Speed 1.5 MPS
Bed Lifts - 20 Pax – Speed 0.75 MPS
**Stops & Openings:**

Lifts shall be required to serve the floors as shown in attached drawing of Lift plan and sections.

**Travel:**

The travel of lifts shall be as specified.

Tenderer shall note that all dimensions are as indicated in the enclosed drawings and his design shall be based on the same. These specifications have been based on Indian standard and equipments available locally as per Indian codes and rules. Equipment from other countries will be acceptable if it is of better quality and competitive in price and conforms to International Standards. The size of hoist way and car enclosure will, however, be the same as specified namely.

**Configuration of Lifts shall be as following**

**Controls:**

Operation of Lifts shall be full collective as Triplex as specified in BOQ

**Shafts Sizes:**

The Shafts sizes shall be as follows:

- Passenger Lifts: - 13 Pax – 2500 mm x 1900 mm
- Bed Lifts: - 20 Pax – 3270 mm x 2350 mm
- Bed Lifts: - 20 Pax – 3000 mm x 2350 mm

**Driving Mechanism:**

The lift shall be provided with A.C, variable voltage, variable frequency, microprocessor controlled motion and drive control system. The tenderer shall indicate the model No. name of manufacturer and country of origin being provided, and the cable size required.

**Operation:**

Each car shall be arranged so that momentary pressure of one or more of its buttons shall cause that car to start.

A car cannot be started unless the car door is in the closed position and all hoist way doors for that car are locked in the closed position.

All the lifts shall be provided with fireman switch.

**Operation with Attendant:**

When the key switch is in position of "without Attendant" the elevator shall operate as described above.

With the key switch in the position of "with Attendant" the direction lights and buzzer shall be operative and "up" direction and the "down" direction buttons in the regular car operating panel shall be effective for the attendant operation.

When on attendant operation, the car and hoist way doors shall open automatically at each stop but the closing of the above shall be subject to the "up" or "down" direction buttons.
As a visual signal to the attendant, the "up" or "down" direction-jewel shall illuminate upon registration either car or landing calls to indicate the travel direction of the car. The attendant shall operate the lift normally in the direction indicated by the direction-jewel. Travel may be realised by the pressure of a car button for a landing in that direction from the car and the direction button in the car operating panel for that direction.

When the key-operated independent service switch is "on" the corresponding car shall operate only from its car button and shall be entirely independent of the other car. The other car shall then operate as a Simplex Collective Elevator responding to its own car calls and all landing calls.

The pressure of direction button shall cause the doors to close and start the car in the direction desired, provided a car on landing call is registered for the direction. If pressure of the direction button is released before the car starts, the doors shall reopen. After the car has started, the direction button can be released and the car shall answer car and landing button calls.

Continuous pressure of the non-stop button shall cause the car to by-pass all landing calls and respond only to registered car calls.

In order to have a car available at the main floor while both lifts are in operation "with Attendant" a "down" light signal shall be registered. Automatically in the first car which clears all its calls. This signal shall indicate to the attendant that this car should be started "down" and pressure of the "down" direction button shall move the car automatically to the main floor.

The car shall also have emergency stop and alarm push buttons. In the machine room manual Cranking device shall be provided.

**MACHINE:-**

The lift machine shall be placed directly above the hoist way upon machine room slab and steel beam and directly above the Car Lift Suitable material like rubber pads of required thickness shall be used below the lift machine to reduce noise and vibrations. The machine shall be of gear type. It shall include a motor, electro mechanical brake, sheave shaft and sheave all completely mounted on a common bed plate. The hard alloy cast iron or steel sheave shall have rope grooves to ensure proper traction and minimize rope wear. Suitable means of lubrication shall be provided for all the bearing. Means for manual operation of the lift car shall be made by providing wiring wheel suitably marked to indicate the direction of the movement of car to enable the lift car to be brought to the nearest landing manually in the event of stoppage of lift due to any reason with a warning display for switching off the electrical supply before operating manually.

**MOTOR:-**

The motor shall be particularly designed for elevator service with high starting torque at low speed and low running current.

**BRAKE:-**

The drive machinery shall be provided with an electromagnetic brake. It shall be spring applied and electrically released type.

The brake shall be capable of operating automatically by the various safety devices, current failure, the failure of any of the several units of the equipment to function in a proper manner and by normal stopping of the car. It shall be so designed that it is capable of stopping and holding the car with load. The operation of brake shall be smooth, gradual and noiseless.

Details of brake installation should be given along with bid.
CONTROL:-

The control shall be variable voltage variable frequency.

CONTROLLER:-

Electro magnetic controller shall be provided with microprocessor with fully computerised control system in machine room to control starting, stopping and to automatically apply the brake in the event of power failure or on operation of safety device. The electrical contacts shall be suitable materials for long life and reliable operation without excessive wear.

CAR FRAME SAFETY GEAR AND GOVERNOR:-

The car frame which supports the car platform and enclosure shall be made of structural steel and equipped with suitable guides and car safety device mounted underneath the car platform. The safety gear shall be of instantaneous type. Car safety, to stop the car whenever excessive descending speed is attained, shall be operated by a centrifugal speed governor located at the top of the hoistway and connected to the governor through a continuous steel rope. Suitable means shall be provided to cut off power from the motor and apply the brake on application of safety. Indicate when the safety gear to stop the car shall become instantaneously operative.

RELAYS:-

Overload relays to protect the driving motor against overloads shall be provided.

TERMINAL AND FINAL LIMITS:-

Terminal switches shall be provided to stop the car at the terminal landings. These terminals switches shall act independently of the operating device or final limit switches. Ultimate or final limit switches shall also be provided to automatically cut off the power and apply brake in case the car travel beyond terminal landings.

TERMINAL BUFFER:-

Suitable spring buffers shall be installed to stop the car and counter weight at the extreme limits of travel. Buffer must be suitable for installation in the space available.

HOIST ROPES:-

Round stranded steel wire ropes shall be used for lift suspension. The number and sizes of the hoisting rope shall be so selected to ensure proper factor of safety and proper operation of the elevator. The suspension ropes shall correspond to relevant Indian Standard. Governor ropes shall also be of steel.

CAR PLATFORM:-

The car platform shall be framed construction and designed on the basis of rated load evenly distributed. Car platform shall be suitably designed to cater for specific designed stone floors.

CAR AND LANDING DOOR OPERATOR:-

An electric door operator for opening and closing the car door and the landing door shall be provided. It shall consist of a machine on the elevator car, operating the door when the car is stopping at a landing. The car door and the landing door shall be mechanically connected and shall move simultaneously in opening and closing. Every landing door shall be provided with a locking device which shall comply with the following requirements:-
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

a) It shall not be possible to open the landing door from the landing side until the lift car is within that particular landing zone. However, provision shall be made for opening the door by means of special key for use in case of an emergency.

b) It shall not be possible for the car to be started or kept in motion unless all the landing doors and car door are closed and locked except when the car is coming to a stop at that landing within the levelling.

c) The electrical and mechanical parts of all locking devices shall be substantial design and construction.

d) An electric contact for the car door shall be provided which shall prevent car movement away from the landing unless the door is in closed position.

The car door and landing door shall open automatically as the car is stopping at a landing. The closing of car door and landing door must occur before the car is set in motion. A device shall be provided to stop and reverse the doors during their closing motion.

DOOR HANGERS AND TRACKS:-

The car and the landing door shall be provided with two point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be of steel with moulded nylon cellar and shall include shielded ball bearing. Tracks shall be suitable steel section with smooth surface. The landing doors shall also consist of heaters, sills, frames, etc. as required.

CAR DOOR SAFETY:--

Infra Red Electronic Door Detectors shall be provided for all the elevators.

CAR OPERATING PANEL IN THE CAR:--

The car operating panel in each car shall be stainless steel sheet of suitable thickness flush mounted. The panel shall contain the following:-

a) A series of push buttons numbered to correspond to the landings served.

b) An emergency stop button.

c) An emergency call button connected to a bell to serve as an emergency signal.

d) A two position key operated switch marked to indicate with attendant and without attendance.

e) A buzzer.

f) Up and down (visual) direction light jewels.

g) A nonstop button.

h) A door open button.

i) A fan switch.

j) All fixtures to be in stainless steel.

CAR DIRECTION INDICATOR:--
Signal indication in the car shall be provided by the appropriate arrow being illuminated to indicate the direction in which the car shall next travel.

**CAR POSITION INDICATOR:**

Suitable signal indication in the car shall be provided by the appropriate numeral being illuminated when the car is passing the corresponding door. This indicator shall remain illuminated when the car is stopped at a floor. The cover of the indicator unit will be stainless steel sheet of suitable thickness:

**EMERGENCY LIGHT IN CAR:**

A battery operated emergency light point with incandescent lamp shall be provided in the car which shall operate automatically in case of power failure.

**ALARM BELL:**

An emergency alarm bell should be provided. The alarm bell shall be located in the ground floor landing and push for the same shall be in the car operating panel. The system shall be operated by batteries with trickle charger and the bell / siren should work the moment the alarm button in the car is pressed.

**CALL BUTTON IN LANDINGS:**

An up push button and a down push button at each intermediate landing and a single push button at each terminal landing shall be provided to call the lift car in a particular landing for travelling in a direction desired. The push buttons shall have call registration lights and shall illuminate when a button is momentarily pressed to indicate that the call is registered and the direction of the call. The button shall remain illuminated until the call is answered. The top covers of landing push button boards shall be of stainless steel sheet of suitable thickness.

**FLOOR POSITION INDICATOR:**

Suitable signal indication at all landing shall be provided by the appropriate numeral being illuminated when the car is pressing the corresponding floor. The indicator shall remain illuminated when the car is stopped at a floor. The top cover of the floor position indicator units shall be stainless steel sheet of suitable thickness.

**DETAILED INSTRUCTIONS:**

Inside the lift car suitable instructions for passenger on metallic plate shall be displayed. Such plates in lift car shall indicate capacity, nos. of persons, No smoking and such other instructions as are suitable for proper and safe operation of the lifts.

**FIREMAN SWITCH:**

Each lift will have fireman switch with glass front break for access of fireman. The operation of this switch shall cancel all calls to this lift and lift will stop at the next nearest landing if travelling upward. The doors will not open at this landing and the lift will start travelling to ground floor. In case of its travel in the downward direction when the fireman’s switch is operated, it will go straight to ground floor direct without stopping enroute. The emergency stop button inside the car will become in-operative during the journey. Once the car has reached the ground floor, it shall be solely under the command of fireman by car buttons, landing calls being isolated. The lift can be put to normal use by putting the fireman switch in its original position.

**EMERGENCY STOP SWITCH:**
On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel. Similar switches shall also be provided in the car operation of these switches shall render the car and landing buttons in-operative and cancel all registered calls.

MICRO SELF-LEVELING: -

The lifts shall be provided with a Micro Self-Levelling feature that shall automatically bring the car to the floor landings. This Micro Levelling shall within its zone, be entirely automatic and independent of the operating device and shall correct for over-travel or under-travel and rope stretch.

PAINTING: -

All lift metal work shall be given one shop coat of rust inhibiting paint in the factory and painted with finishing coats on site. Factory finished powder coated paint to desired shade is acceptable. Any damage caused during erection of the equipment shall be repaired to restore it to required finish.

AUTOMATIC RESCUE DEVICE (ARD): -

All the lifts shall be programmed for ARD (Automatic Rescue Device) which shall enable the lifts to stop at the nearest floor in the event of power failure/ shutdown/ breakdown and the doors to be opened, so that any passengers in the lift would not be trapped inside the lift cars in such eventuality.

WEIGHT FOR CAR INTERIOR: -

Car interior work weight should not exceed 300 kg.

ELECTRICAL EQUIPMENT AND WIRING

SCOPE: -

The scope of this section comprises supply, installation and wiring of all electrical equipment including control wiring. Power supply at 415 V, 3 phase, 50 Hz, 4 wire with double earthing will be supplied by the Owner in the machine room with a MCCB in sheet steel enclosure for each lift. All further wiring to motors and controllers, hall buttons, alarm bell, car position indicators etc. shall be provided by the lift Contractor.

A separate DB shall also be provided in the lift machine room for lighting, socket outlets, drilling machine, etc. by the Electrical Contractor.

WIRING: -

All wires and cables shall be insulated with polyvinyl chloride base insulation rendered flame retardant armoured and rated for 1100 volt service and suitable for use in dry and wet locations. Makes of wires and cables shall be subject to the approval of the Consultant before delivery.

All control wiring shall be of copper.

Wires and cables subject to movement and abrasion shall be protected by flexible galvanized steel conduit.

Traveling cables shall be of best grade for the service and shall originate at steel junction boxes in hoist way and at steel junction boxes on the car, hung so that the proper size loop may be obtained. they shall have a fire and moisture resistant outer covering and contain a steel supporting strand. Traveling cables shall be suitably suspended to relieve strains in individual conductors. Traveling cables shall be provided for telephone, signals, controls, lights, fans, alarm bell, emergency circuit, music and communication with control room etc.

Earthing of all equipment is in the scope of the lift contractor.
ELECTRIC POWER SUPPLY

All the equipments shall be suitable for operating within a range of ± 10%. Any equipment which cannot be operated with the above mentioned power supply shall be provided with necessary Transformer / Rectifier / Stabilizer at bidder’s own cost. The power shall be provided at one point in each machine room at the location indicated by the contractor. Further power distribution shall be in the scope of the contractor.

RULES FOR SAFETY & LABOUR WELFARE

The CONTRACTOR shall comply with the safety and Labour Welfare Rules, as given hereunder & as per the Rules and Regulations framed by Local Authorities / Statutory Bodies / State / Central Govt. from time to time:-

FIRST AID POST:- The CONTRACTOR shall provide and maintain in a readily accessible place First Aid appliances including adequate supply of sterilized dressings, guage, cotton wool and requisite medicines, as prescribed in the Factory Rules of the place in which work is carried on. In case of a large work place the First Aid Post shall be run by a trained compounder. In case of accident, the CONTRACTOR shall provide suitable transport to facilitate removal of urgent cases to Hospitals etc (One Omni / Van with driver shall be provided at site and maintained by the CONTRACTOR at his own cost for 24 Hrs. & shall work as ambulance in case of emergency).

SAFETY EQUIPMENT:- All necessary personal safety equipment such as Helmets (with approved colour scheme), Protective footwear, protective goggles / eye shields, Life Jacket, Gas masks etc. as considered adequate by the ENGINEER-IN-CHARGE shall be available for use of persons employed on the Site and maintained in a condition suitable for immediate use; and the CONTRACTOR shall take adequate steps to ensure proper use of equipment by those concerned.

a) Workers employed on mixing asphaltic materials, cement and lime mortars / concrete shall be provided with protective footwear and protective goggles.
b) Those engaged in handling any material which is injurious to eyes shall be provided with protective goggles.
c) Those engaged in welding works shall be provided with welder’s protective eye-shields.
d) Stone-breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
e) When workers are employed in sewers and manholes, which are in use, the CONTRACTOR shall ensure that manhole covers are opened and manholes are ventilated at least for an hour before workers are allowed to get into them. Manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to public.
f) The CONTRACTOR shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting, the following precautions shall be taken:-

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

i) Suitable face-masks shall be supplied for use by workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.

ii) Overalls shall be supplied by the CONTRACTOR to workmen and adequate facilities shall be provided to enable working painters to wash during and on cessation of work.

SAFETY PRECAUTIONS:- Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites shall be so stacked or placed as to cause danger.
or inconvenience to any person of the public. The CONTRACTOR shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of defence of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damage and costs 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 compromise any claim by any such person.

SCAFFOLDINGS:- Suitable scaffolds shall 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 form 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, suitably footholds and hand-holes shall be provided on the ladder and the ladders shall be given an inclination not steeper than $\frac{1}{4}$ to 1 (1/4 horizontal and 1 vertical).

GUARD RAILS:- Scaffolding or staging more than 3.25 metres above the ground or floor, swung or suspended from an overhead support or erected with stationery support, shall have a guard rail properly attached, bolted, braced and otherwise secured at least 1 metre 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 openings 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.

RIGID DESIGN:- Working platform, gangways, and stairways shall be so constructed that they do not sag unduly or unequally, and if height of a platform or gangway or stairways is more than 3.25 metres above ground level or floor level, it shall be closely boarded, have adequate width and be suitably forced, as described in sub-Para 4.05 above.

OPENINGS GUARDED:- Every openings in floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or railing with a minimum height of 1 meter.

EXCAVATIONS SAFETY:- All excavations, 1.5 metres or more in depth, shall at all times be supplied with at least one ladder for each 30 metres in length or fraction thereof. Ladder shall be extended from bottom of trench to at least 1 metre above surface of the ground. Sides of a trench which is 1.5 metres or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing. Excavated materials shall not be placed within 1.5 metres of edge of excavations or half of depth of excavations whichever is more. Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting be done.

DEMOLITION:- Before any demolition work is commenced and also during the process of the work.

a) All roads and open areas adjacent to the work site shall either be closed or suitably protected.
b) No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by operator shall remain electrically charged.
c) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion, or flooding. No floor, roof or other part of a building shall be so overloaded with debris or materials as to render it unsafe.

SAFETY AGAINST DROWNING:- When work is done near any place where there is risk of drowning, all necessary safety equipment shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

HOISTING MACHINES:- Use of hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following :-

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

b) Every crane driver of hoisting appliance / operator shall be properly qualified and no person under the age of 21 years shall be in-charge of any hoisting machine including any scaffold winch or to give signals to the operator.

c) In case of every hoisting and of every chain ring hook, shackle swivel and pulley block used in hoisting or lowering or as means of suspension, safe working load shall be ascertained by adequate means. Every Hoisting machine and all gear referred to above shall be plainly marked with 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 of any gear referred to above in this paragraph shall be loaded beyond safe working load except for the purpose of testing.

d) In case of usage of an OWNER supplied machine, safe working load shall be notified by the Engineer-In-Charge. As regards CONTRACTOR’S machines the CONTRACTOR shall notify safe working load of each machine to the ENGINEER-IN-CHARGE whenever he brings it to site of work and get it verified by the ENGINEER-IN-CHARGE.

SAFE-GUARDS FOR MOVING & DANGEROUS PARTS:— Motors gearing, transmission, electric wiring and other dangerous parts of hoisting appliance shall be provided with efficient safe guards; hoisting appliance shall be provided with such means as will reduce to the minimum risk of accidental descend of load. Adequate precautions shall be taken to reduce to the minimum risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energized, insulating mats, working apparel such as gloves, sleeves and boots, as may be necessary, shall be provided. Workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

Necessary warning sign boards in Red / White paint, with proper lighting arrangements for nights are to be provided by CONTRACTOR at his costs, as approved by ENGINEER-IN-CHARGE at prominent locations. The arrangements for providing and maintaining all such safety and labour welfare measures etc., shall be done at CONTRACTOR’S own cost and expenses.
The project is being designed to attain **GRIHA 3 star and LEED Platinum rating**. The contractor has to maintain all the clauses mentioned below and also maintain the necessary documentation of the various works. Nothing extra shall be paid on account of these requirements.

Following are the contractor’s responsibilities but not limited to:
CONSTRUCTION OF MEDICAL COLLEGE & HOSPITAL SUNDARGARH, ORISSA

The contractor to submit the Project Management Plan showing the material storing yard, Batching Plant, facilities for labour (Accommodation, toilets etc), approach roads, site office of owner, PMC and Contractor, location for preservation of top soil, staging and spill prevention measures, erosion and sedimentation control measures etc. The plan should be such that area of disturbance should be minimum and get the same approved by Engineer-In-Charge prior to start of work at site.

1. PRESERVE AND PROTECT LANDSCAPE DURING CONSTRUCTION

1.1 Collection, storage and reaplication of topsoil

1.1.1 Soil Test has to be carried out and also soil baring test needs to be carried out.
1.1.2 Contractor to ensure that the soil on-site is protected from erosion in accordance with NBC 2005 – Part 10 – Landscaping, Signs and Outdoor Display Structures, Section 1 – Landscape planning and design, Subsection 4 – Protection of landscape during construction.
1.1.3 This should be done from areas likely to be disturbed by construction activities (especially in cases where the site area is larger than 10,000 m2), topsoil should be stripped to a depth of 20 cm from the areas proposed for buildings, roads, paved areas, and external services.
1.1.4 It should be stockpiled to a height of 40 cm in designated areas and reapplied during plantation of the proposed vegetation. The topsoil should be separated from the subsoil debris and stones larger than 50 mm in diameter.
1.1.5 The adjoining areas shall be barricaded to prevent construction activities damaging the surrounding areas.

1.2 Sedimentation basin

1.2.1 Sedimentation basin, a temporary dam or basin at the lowest convenient point of the site should be constructed for collecting, trapping, and storing sediment produced by the construction activities.
1.2.2 A flow-detention facility must also be constructed for reducing peak run-off rates. This would allow most of the sediments to settle before the run-off is directed towards the outfall.

1.3 Contour trenching

1.3.1 Contour trenching is an earth embankment or ridge-and-channel arrangement constructed parallel to the contours, along the face of the slope, at regular intervals on the lengths and slopes greater than 10% (1:10).
1.3.2 They are used for reducing run-off velocity, increasing the distance of overland run-off flow. They are also used to hold moisture and minimize sediment loading of surface run-off.

1.4 Mulching

1.4.1 Mulch is a protective layer of material that is spread on the top of the soil, which can either be organic (such as grass clippings, straw, bark chips, and similar materials) or inorganic (such as stones and brick chips).
1.4.2 Mulching should be used with seedings and plantings on steep slopes (slopes>33%). Steep slopes are prone to heavy erosion and, therefore, netting or anchoring should be used to hold it in place.

1.5 Topsoil improvement

1.5.1 Topsoil needs to be tested before preservation to ensure that it is worth preserving, and will help conserve resources and money in the long run.
1.5.2 The soil should be tested at a laboratory accredited by the Indian Council of Agricultural Research (ICAR) for primary plant nutrient and pH. In case the soil test conducted yields a result that is not up to the requisite standard, then adequate measures need to be adopted to ensure that the fertility of the soil is restored to a usable level as per the direction of Engineer-In-Charge.

1.6 Preservation of existing Trees and preventing damage to the same During Construction

During construction, protection of existing vegetation (including trees, shrubs, grasses and other plants) where possible, by preventing disturbance or damage to specified areas is recommended. This practice minimizes the amount of bare soil exposed to erosive forces.

Trees retained on the project site shall be protected during the construction period as per National Building Code – Part 10: Landscaping, signs, and outdoor display structures.

Copy of permission letter to be provided for cutting of trees.

1.7 Documentation
1.7.1 Site plan showing staging and spill prevention measures, erosion and sedimentation control measures.

1.7.2 Document to be submitted after completion of the project, a brief description along with photographic records to show that other areas have not been disrupted during construction. The document should also include brief explanation and photographic records to show erosion and sedimentation control measures adopted. (Document CAD drawing showing site plan details of existing vegetation, existing buildings, existing slopes and site drainage pattern, staging and spill prevention measures, erosion and sedimentation control measures and measures adopted for top soil preservation during construction).

1.7.3 Site plan (one CAD drawing) along with a narrative to demarcate areas on site from which topsoil has to be gathered, designate area where it will be stored, measures adopted for topsoil preservation.

1.7.4 Obtaining Certificate from landscape architect confirming proper protection and preservation of existing trees during construction process.

1.7.5 Landscape plan, clearly highlighting the areas where trees were removed (indicating the number of trees), if applicable, with the number of replanted trees in the proportion of 1:3 in the proposed landscape design. List details about species, which existed, and the species that have been replanted on-site.

1.7.6 Narrative explanation about the methods of soil stabilization used, wherever required, accompanied by photographs with brief description.

1.7.7 Certificate by the landscape architect on topsoil laying, soil stabilization, and adequate primary soil nutrient and pH [(supported by test results performed at Indian Council of Agricultural Research (ICAR)-accredited laboratory].

2. PROVIDE MINIMUM LEVEL OF SANITATION/SAFETY FACILITIES FOR CONSTRUCTION WORKERS

2.1.1 Drinking water facility provided for workers, all such points shall be legibly marked "Drinking Water" in a language understood by a majority of the persons employed in such place and no such point shall be situated within six meters of any washing place, urinal or latrine.

2.1.2 Contractor shall provide minimum level of sanitation facilities and ensure safety of construction workers as per guidelines given in The National Building Code of India (Latest version). Toilets provided for workers, the temporary accommodation provided shall have separate cooking place, bathing, washing and lavatory facilities.

2.1.3 Provision for crèche if female workers: Such rooms shall- provide adequate accommodation; be adequately lighted and ventilated; be maintained in a clean and sanitary condition; be under the charge of women trained in the care of children and infants.

2.1.4 To provide and maintain in every place wherein not less than two hundred and fifty building workers are ordinarily employed a canteen for the use of the workers;

2.1.5 Safety helmets, vests, boots and safety harness should be provided mandatorily.

2.1.6 In case of any death or injury on the site, by reason of which the person injured is prevented from working for the period of forty-eight hours or more immediately following the accident, or which is of such a nature as may be prescribed.

2.2 Documentation
Contractor shall take regular photographs showing the health, safety and sanitation measure followed during construction and maintain the record of the same.

Contractor shall submit the detailed narrative on provision for safe drinking water and sanitation facility for construction workers and site personnel accompanied by the photographs taken at regular intervals during construction.
3 REDUCE AIR POLLUTION DURING CONSTRUCTION
Contractor shall prepare a dust and air pollution control plan and get the same approved by Engineer-In-Charge prior to start of construction.

3.1.1 Barricading
Temporary and permanent barricading shall be provided in height around construction area of either full brick wall or dust screens, sheeting or netting has to be provided along the sides of existing building and road.

3.1.2 Wheel Washing Pit
Construct and maintain the wheel washing pit to prevent erosion by construction vehicles at all entrances of the site.

3.1.3 Water spraying
Use water as a dust suppressant. Spray water over areas where demolition work is being carried out. Ensure that all vehicles and gensets use cleaner fossil fuels like ultra low sulphur diesel.

3.2 Cover and enclosure
Cover all loose stored material with geotextile or any impervious fabric or covering. Cover all dusty loads on vehicles with impervious sheeting before they enter or exit the site.

Store loose materials in enclosed spaces. Provide wind barriers or fences or wind breakers around the area where loose soil, sand, etc., are stored.

Store materials on site in an area away from sensitive areas surrounding the site like schools, hospitals, etc.

All gensets should be maintained properly. The gensets used on site should meet the recommended pollution norms. Minimum stack height should be provided for all gensets based on height of the building and capacity of the gensets.

The contractor shall submit the narrative document with support of site photographs demonstrating implementation of actual measure and a short description of each measure.

3.3 Documentation
Contractor to submit the narrative (not more than 300 words) explaining the air pollution preventive measures that have been adopted on-site. Site photographs showing different stages of construction along with preventive measures to support of the same.

4 EFFICIENT WATER USE DURING CONSTRUCTION
4.1.1 Contractor shall use curing compound for curing the concrete as per the specifications mentioned elsewhere in the tender document.

4.1.2 Curing water should be sprayed on concrete structures; free flow of water should not be allowed for curing.

4.1.3 After liberal curing on the first day, all concrete structures should be painted with curing chemical to save water. This will stop daily water curing hence save water.

4.1.4 Concrete structures should be covered with thick cloth/gunny bags and then water should be sprayed on them. This would avoid water rebound and will ensure sustained and complete curing.

4.1.5 Ponds should be made using cement and sand mortar to avoid water flowing away from the flat surface while curing.

4.1.6 Water ponding should be done on all sunken slabs

4.1.7 Adequate provision for recycling of waste water generated on site during construction activities.

4.1.8 Adequate storage provision for rain-water and reuse on site.

4.1.9 Recycled treated water to be used for curing

4.2 Documentation
Contractor to submit the narrative explaining the efficient water use during construction accompanied by regular photographs of curing showing the use of concrete compound as per the direction of Engineer-In-Charge.
5 USE OF LOW-VOC PAINTS/ADHESIVES/SEALANTS

Contractor to ensure that all the Adhesives, Sealants, Paints and Coatings used in the project have a VOC level within the following limits. Maintain proper documentation in the form of manufacturer cut sheets, technical data sheets, and lab test reports as conformation for compliance.

100% of all paints should be under the provided VOC limits for paints and to use use water–based rather than solvent-based sealants and adhesives.

<table>
<thead>
<tr>
<th>Paint applications</th>
<th>VOC limits (g of VOC per lt)</th>
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</thead>
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<tr>
<td>Interior coating</td>
<td>Flat &lt;50</td>
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<td>Non Flat &lt; 150</td>
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<td>Exterior Coating</td>
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<td>Non Flat &lt;100</td>
</tr>
<tr>
<td>Anti Corrosive</td>
<td>Gloss/semi gloss/flat &lt; 250</td>
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</table>

6 STORM WATER MANAGEMENT DURING CONSTRUCTION:

Contractor needs to take measures to ensure that the storm water runoff during construction does not exceed the runoff before construction. To this effect there is need to provide rain water recharge pits right around the periphery of the site & have rain water harvesting wells to capture rain water and then filter all suspended solids and other materials before recharge into the earth.

7.1 CONSTRUCTION WASTE MANAGEMENT REDUCTION IN WASTE DURING CONSTRUCTION

7.1.1 Separate bins to be constructed for storage of sand and aggregate.
7.1.2 Separate bins to be constructed for storage of construction waste like scrape steel, cement debris, empty cement bags, paint buckets etc and other construction wastes.
7.1.3 Hazardous wastes like spent diesel and batteries be also sold to designated vendors 7.1.4 Spent diesel shall not be reused as shuttering oil or for any other construction purpose.

7.2 Documentation

Contractor to submit the narrative indicating the quantum of waste generated during construction and storage facility for segregated inert and hazardous waste before recycling and disposal accompanied by necessary documents and photographs.

Contractor to submit the layout (showing the location & capacity) and photo of the storage facility for segregated inert and hazardous waste

Contractor to ensure that a plan is in place to ensure that more than 75% of the waste generated by weight or volume, on-site due to construction activities is either reused, recycled or sold as scrap and is diverted from going into landfills.

Contractor to submit the proper records/documents in the form of logs, photographs, gate passes, hauler certificates, etc. for compliance of the same.

Contractor to submit the proper records/documents in the form of logs, photographs, gate passes, hauler certificates, etc. for compliance of the same.

8 RECYCLED CONTENT IN MATERIALS

Contractor to submit the letters confirming the recycled content (post-consumer and pre-consumer) in the materials from the manufacturers. Recycled content in the various materials is given below:

a. Glass- Minimum recycled content of 10-15%
b. Steel – Minimum recycled content of 25%
c. Gypsum Board- Minimum recycled content of 20-25%
d. Aluminum - Minimum recycled content of 25%
e. Fly sash in AAC Blocks, Cement Plaster, RMC- Minimum recycled content of 25-50%

Contractor to maintain documentation records in the form of Manufacturer cut-sheets, Technical data sheets and/or test reports to confirm compliance of the same. Post-consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the
product, which can no longer be used for its intended purpose. Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

**REGIONAL MATERIALS**
Contractor to procure materials which are extracted, harvested or recovered and manufactured/processed within a 250-mile (400km) radius of the project site as far as possible and ensure that more than 20% of the materials by cost are extracted, harvested or recovered and manufactured/processed regionally within a 250-mile (400km) radius.

Contractor to maintain and submit documentation records in the form of Manufacturer letters indicating the place of manufacture/process and place of raw material extraction/harvesting and the distance of both from the project site to ensure compliance with the above.

**10 COMPOSITE WOOD AND AGRIFIBER PRODUCTS**
Composite wood and agrifiber products used in the interior of the building must contain no added urea-formaldehyde resins. Composite wood and agrifiber products are defined as: particleboard, medium density fibreboard (MDF), plywood, wheat board, strawboard, panel substrates and door cores. Substitute resins include Phenol Formaldehyde, Melamine Formaldehyde or Epoxy resins.

Contractor to submit and maintain proper documentation in the form of manufacture cut sheets, technical data sheets, lab test reports indicating the resin used for all composite wood and agrifiber products as conformation for compliance.

**ADDITIONAL SPECIAL CONDITIONS –GRIHA**
In order to comply with the criterion laid down by GRIHA following mandatory practices shall be followed by the contractor. In addition the tender rates shall be deemed to include the following:

A. The contractor shall comply with safety procedures, norms and guidelines (as applicable) as outlined in the Doc No. CED 46(6086), July 2003: Draft National Building Code of India: Part 7 Constructional practices and safety, issued by Bureau of Indian Standards.

I. Site Boundary
Boundary shall be fenced with an opaque material which shall not allow air pollution and soil erosion due to wind. Temporary and permanent barricading shall be provided in height around construction area of either full brick wall or dust screens, sheeting or netting has to be provided along the sides of existing building and road.

II. Site preparation
- Clear vegetation only from the areas where work will start right away
- Vegetate/mulch areas where vehicles don’t ply. Mulch is a protective layer of material that is spread on the top of the soil, which can either be organic (such as grass clippings, straw, bark chips, and similar materials) or inorganic, (such as stones and brick chips). Mulching should be used with seedings and plantings on steep slopes (slopes>33%). Steep slopes are prone to heavy erosion and, therefore, netting or anchoring should be used to hold it in place.
- Apply gravel to the area where mulching/paving is impractical
- Identify roads on site that would be used for vehicular traffic. Add surface gravel to reduce source of dust emission
- Limit vehicular speed on site to 10 km/hour

III. Existing Site Features
• Conserve existing natural areas or existing natural features on site such as water bodies, trees etc to integrate in the design and to provide habitat and promote biodiversity
• Carry out a comprehensive site analysis to identify site characteristics that can be used to harness natural resources (like solar energy, wind, and water) and the potential qualities of the landforms that could contribute to making different areas of the site visually and thermally more comfortable for users. Locate various activities of the scheme after careful site analysis and assessment so as to protect ecologically sensitive areas and reduce damage to the natural ecosystem

IV. A. Preserve and protect existing vegetation on site
• Inventory of existing vegetation including the number of trees and native shrub coverage and their species types. This has to be done before any construction activity starts on site
• Preserve existing mature trees on-site during the course of construction by preserving and transplanting them. Preservation and protection of existing vegetation by non-disturbance or damage to specified site areas is recommended. Site vegetation includes trees, shrubs, grasses and other plants. Where ever possible, existing site vegetation has to be included in the landscape design of the site. This practice enables retention of fully-grown mature trees and also reduces avoidable erosion of bare soil
• The contractor shall undertake the responsibility to ensure that the site is not ‘levelled’ or ‘cleared’ before undertaking this study
• Site plan, with photographs, clearly highlighting the trees and native shrub coverage that is protected, transplanted or removed has to be recorded or maintained by the site engineer

B. Procedure to Monitor and Protect Site Vegetation
• All existing vegetation shall be marked on a site survey plan
• A vegetation survey in the prescribed format shall be carried out by an accredited landscape architect and attached to the site survey plan
• The above specifications to be implemented at site as per NBC part 10 – Landscaping, Signs and outdoor display
• Copy of permission letter to be provided for cutting of trees.

C. Transplanting Existing Trees on Site
• If trees have to be removed from their location or have to be felled for any of the above reasons, efforts should be made to transplant them as much as possible. For this
• Large trees identified for transplantation should be replanted at a different location immediately
• Young trees or saplings identified for transplantation can be uprooted and preserved for replanting after the completion of construction. Young trees are those that have a height less than 2 m, and a 0.1 m trunk girth at 1 m height from ground, and a 2 m crown diameter
• Non Applicability condition: Sites that are devoid of trees

D. Compensatory Plantation on Site
• Where trees cannot be transplanted due technical and economical reasons, compensatory plantation has to be undertaken on the site.
• Compensate the loss of vegetation (trees) due to the construction activity by compensatory plantation.
• Replant the same number of mature or fully grown trees as eliminated during the construction of the proposed landscape design. Replant the same, native and/or non-invasive species, which existed on the site before elimination in the proportion of 1:3.
• Plant in excess of 25% to the minimum required within the site premises
• The above specifications to be implemented at site as per NBC part 10 – Landscaping, Signs and outdoor display

V. Construction management process requirements
A. Timing of construction
• Select proper timing for the construction activity to minimize site disturbance such as soil pollution due to spilling of the construction material and its mixing with rainwater
B. Staging
- Staging is dividing a construction area into two or more areas to minimize the area of soil that will be exposed at any given time. Staging should be done to separate undisturbed land from land disturbed by construction activity and material storage.
- Use staging and spill prevention and control plan to restrict the spilling of the contaminated material on site.
- Specify and limit construction activity in pre-planned/designated areas.

C. Soil erosion and sedimentation control measures
- Soil Test has to be carried out and also soil baring test needs to be carried out. Topsoil needs to be tested before preservation to ensure that it is worth preserving, and will help conserve resources and money in the long run.
- The soil should be tested at a laboratory accredited by the Indian Council of Agricultural Research (ICAR) for primary plant nutrient and pH. In case the soil test conducted yields a result that is not up to the requisite standard, then adequate measures need to be adopted to ensure that the fertility of the soil is restored to a usable level as per the direction of Engineer-In-Charge.
- Preserve topsoil by employing measures as following -
  - Contractor to ensure that the soil on-site is protected from erosion in accordance with NBC 2005 – Part 10 – Landscaping, Signs and Outdoor Display Structures, Section 1 – Landscape planning and design, Subsection 4 – Protection of landscape during construction
- Protect the top soil from erosion. Use collection storage and reapplication of the top soil, sediment basin, contour trenching, mulching, soil stabilization methods to protect the top soil from erosion during construction.
- Measures shall be followed for collecting drainage water runoff from construction areas and material storage sites through temporary drainage trenches, silt fences, bio-infiltration ponds or structural controls such as sedimentation tank or water collection chambers to reuse water for curing etc.
- The Contractor shall construct Sedimentation basin, a temporary dam or basin at the lowest convenient point of the site. This should be constructed for collecting, trapping, and storing sediment produced by the construction activities, together with a flow detention facility for reducing peak runoff rates. This would allow most of the sediments to settle before the runoff is directed towards the outfall.

D. Soil conservation (till post-construction)
- Proper topsoil laying, stabilization of the soil, and maintenance of adequate fertility of the soil to support vegetative growth. The top soil conservation should be done from areas likely to be disturbed by construction activities (especially in cases where the site area is larger than 10 000 m2), topsoil should be stripped to a depth of 20 cm from the areas proposed for buildings, roads, paved areas, and external services.
- It should be stockpiled to a height of 40 cm in designated areas and reapplied during plantation of the proposed vegetation. The topsoil should be separated from the subsoil debris and stones larger than 50 mm in diameter.
- The adjoining areas shall be barricaded to prevent construction activities damaging the surrounding areas.
- Non applicability condition proposed (for top soil preservation only): Contaminated sites/sites that do not have good quality top soil (as per soil test report) that is considered worth storing for reuse. Soil test has to be carried out as per criteria 3 and the test report has to be endorsed by the landscape architect. The landscape architect has to provide certificate that the top soil is not worth storing for landscaping purposes and cannot be restored to applicable standard.

VI. Reduce air pollution during construction
• The contractor shall undertake the responsibility to prevent air pollution dust and smoke; ensure that there will be adequate water supply / storage for dust suppression; devise and arrange methods of working and carrying out the work in such a manner as to minimize the impact of dust on the surrounding environment, and provide experienced personnel with suitable training to ensure that these methods of working, plant, equipment and air pollution control system to be used on the site should be made available for the inspection and approval of the engineer-in-charge of construction to ensure that these are suitable for the project.
• The contractor shall comply to CPCB standards to prevent air pollution, dust and smoke on the site. These standards shall be applicable to the use of DG sets during construction and the stack height of the DG stack to control air pollution should be as per the CPCB standards.

Site maintenance policies should include -

A. Water spraying.
• This will be done by wetting the surface by spraying water on-
• Any dusty materials before transferring, loading, and unloading.
• Areas where demolition work is being carried out.
• Any unpaved main haul road.
• Areas where excavation or earth-moving activities are to be carried out.

B. Cover and Enclosure
• Providing hoardings/ GI sheet barricading of not less than 3m high along the site boundary, next to a road or other public area. An existing brick boundary wall exists at site on some sides. The Contractor shall be required to erect a GI sheet barricading over the same.
• Providing dust screens, sheeting or netting along the perimeter of a building.
• Covering fully stockpile of dusty material with impervious sheeting.
• Covering dusty load on vehicles by impervious sheeting before they leave the site.
• Transferring, handling/storing dry loose materials like bulk cement, dry pulverized fly ash inside a totally enclosed system.
• Stack height of the DG stack to control air pollution should be as per the CPCB standards.

VII. Reduce Noise Pollution during construction on site
• To use appropriate noise controls for providing acceptable levels of outdoor and indoor noise levels to enhance comfort ensure that the outdoor noise level conforms to the Central Pollution Control Board- Environmental Standards-Noise (ambient standards).
  The report on measured average ambient noise level at site- Noise measurement should be conducted by an organization recognized by a competent authority and it should follow procedures laid down by a competent authority.
• Mechanical, electrical, air conditioning, heating and mechanical ventilation and other services if are provided - noise control measures should be incorporated during the design and installation of such services to adhere to the recommended outdoor and indoor noise criteria for the kind of occupancy.
• Some basic techniques to achieve the same are given in National Building Code, Part - VIII, Section 4, Annex G.

VIII. Aggregate Utility corridors
• Use aggregate utility corridors.
• Consolidate utility corridors along the previously disturbed areas or along new roads, in order to minimize unnecessary cutting and trenching and to ensure easy maintenance. Local codes and requirements for water, sewer, and electrical/telecommunication lines should be considered.
• Consolidate services, pedestrian, and automobile paths.

IX. Efficient Water Use during Construction
• Minimize use of potable water during construction activity by-
• Controlling wastes of curing water
• To avoid wastage of curing water, follow the following guidelines
• Curing water should be sprayed on concrete structures; free flow of water shall not be allowed.
• After liberal curing on the first day, all concrete structures shall be painted with curing chemical to save water. This will stop daily water curing hence save water. (to be covered under tender items)
• Concrete structure shall be covered with thick cloth/gunny bags and then water should be sprayed on them. This would avoid water rebound and ensure sustained and complete curing.
• Ponds shall be made using cement and sand mortar to avoid water flow away from the flat surface while curing (to be covered under tender items)
• Water ponding shall be done on all sunken slabs; this would also highlight the importance of having an impervious formwork.
• Use recycled treated water

• **Storm water management during construction**
  o Contractor needs to take measures to ensure that the storm water runoff during construction does not exceed the runoff before construction. To this effect there is need to provide rain water recharge pits right around the periphery of the site & have rain water harvesting wells to capture rain water and then filter all suspended solids and other materials before recharge into the earth.

**X. Utilization of flyash in building structure**

• **Fly ash use in RC**: Minimum 15% replacement of cement with fly ash by weight of cement used in the total structural concrete. Provide supporting document from the manufacturer of the cement specifying the fly ash content in PPC used in reinforced concrete.

• **For use of fly ash in building blocks of load bearing and non-load bearing wall**: Minimum 40% replacement of cement with fly ash by weight, for 100% load bearing and non-load bearing walls. Provide supporting document from the manufacturer of the pre-cast building blocks specifying the fly ash content of the blocks used in an infill wall system.

• **For use of fly ash in plaster and masonry mortar**: Minimum 30% use of fly ash in place of cement by weight in overall plaster and mortar requirement. Provide supporting document from the manufacturer of the cement/ready mix concrete, specifying the fly ash content in PPC used in plaster and masonry mortar

**XI. Use of low VOC paints adhesives and sealants**
Contractor to ensure that all the Adhesives, Sealants, Paints and Coatings used in the project have a VOC level within the following limits. Maintain Proper documentation in the form of manufacturer cut sheets, technical data sheets, and lab test reports as conformation for compliance. 100% of all paints should be under the provided VOC limits for paints and to use water-based rather than solvent-based sealants and adhesives.

<table>
<thead>
<tr>
<th>Paint applications</th>
<th>VOC limits (g of VOC per lt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior coating</td>
<td>Flat &lt;50</td>
</tr>
<tr>
<td></td>
<td>Non Flat &lt; 150</td>
</tr>
<tr>
<td>Exterior Coating</td>
<td>Flat &lt;200</td>
</tr>
<tr>
<td></td>
<td>Non Flat &lt;100</td>
</tr>
<tr>
<td>Anti Corrosive</td>
<td>Gloss/semi gloss/flat &lt; 250</td>
</tr>
</tbody>
</table>

**XII Recycled Content in materials**
Contractor to submit the letters confirming the recycled content (post-consumer and pre-consumer) in the materials from the manufacturers. Recycled content in the various materials is given below:

f. Glass- Minimum recycled content of 10-15%
g. Steel – Minimum recycled content of 25%
h. Gypsum Board- Minimum recycled content of 20-25%
i. Aluminium - Minimum recycled content of 25%
j. Flysash in AAC Blocks, Cement Plaster, RMC- Minimum recycled content of 25-50%
Contractor to maintain documentation records in the form of Manufacturer cut-sheets, Technical data sheets and/or test reports to confirm compliance of the same. Post-consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

**XIII Regional Materials**
Contractor to procure materials which are extracted, harvested or recovered and manufactured/ processed within a 250mile (400km) radius of the project site as far as possible and ensure that more than 20% of the materials by cost are extracted, harvested or recovered and manufactured / processed regionally within a 250mile (400km) radius.

Contractor to maintain and submit documentation records in the form of Manufacturer letters indicating the place of manufacture/process and place of raw material extraction/harvesting and the distance of both from the project site to ensure compliance with the above.

**XIV. Reduce volume and weight and time of construction by adopting efficient technologies**

**Structural application**
- Use of low-energy technologies in structural application clearly demonstrating a minimum 5% reduction in high energy materials such as cement, concrete, steel, sand, bricks by absolute volume when compared with equivalent products for the same application, for 100% structural system used in a building, meeting the equivalent strength requirements. For e.g. Post tensioned systems, precast systems etc.

**Non-structural application**
- Use of low-energy technologies/materials (not based on the utilization of industrial waste), which are used for non-structural applications such as infill wall system and cause a minimum 5% reduction in the use of high-energy materials such as cement, concrete, steel, and so on. by absolute volume when compared with equivalent products for the same application, for 100% infill wall system used in a building, meeting the equivalent strength requirements. For e.g. light weight concrete blocks over dense concrete blocks, pre-cast brick panels, composite ferrocement walling, interlocking concrete blocks etc

**XV. Reduction in the Waste during Construction**
- The contractor is required to develop Waste Management Programme (WMP) during the construction of the project for his works, which may include:
- The Contractor shall ensure maximum recovery and safe disposal of wastes generated during construction and reduce the burden on landfill.
- Employ measures to segregate the waste at site into inert, chemical, or hazardous wastes. For this the contractor shall construct separate coloured bins for collection of different categories of waste at site and maintain strict discipline among the labour in segregating the waste.
- The Contractor shall recycle the unused chemical/ hazardous wastes such as oil, paint, batteries and asbestos. The Contractor shall dispose off the inert waste by Municipal Corporation at landfill sites.
- Recycle the hazardous waste and dispose the inert waste to municipal approved landfill sites.
- Minimize factors that contribute to waste such as over-packaging, improper storage, ordering errors, poor planning, breakage, mishandling, and contamination of construction materials. For waste volumes generated, identify and institute reuse, salvage and recycle opportunities whenever economics and logistics allow
- Develop and institute a construction waste management plan that identifies proposed deconstruction and salvage opportunities, on-site reprocessing and reuse opportunities

**XVI. Storage of materials and equipment at site**
• The Contractor shall, at his own cost, provide adequate storage sheds and yards at the Site, at locations pre-approved by the Engineer, for all materials and equipment that are to be incorporated in the Work. This shall be for all the materials and equipment, supplied by the Contractor or any Sub-Contractor or supplied by the Employer / Engineer.

• In addition to being watertight and weatherproof, the storage facilities shall be of such a manner that all the materials and equipments are adequately protected in every way from any deterioration or contamination or damage whatsoever, to the complete satisfaction of the Engineer. The method of storing of all the materials and equipment shall be in conformity with the Specifications and/or to the directions and instructions of the Engineer. At no time shall any material or equipment be stored in open or in contact with the ground. Should any of the materials or equipment deteriorate or be contaminated or damaged in any way due to improper storage or for any other reason than such materials and equipment shall not be incorporated in the Work and shall be removed forthwith from the Site and the replacement of all such materials and equipment shall be entirely at the cost and expense of the Contractor.

• Wherever applicable the storage of materials shall be in accordance with the relevant Indian Standard Specifications

XVII. Provide at least the minimum level of accessibility for persons with disabilities as applicable

• Ensure access to facilities and services by adopting appropriate site planning to eliminate barriers as per the recommended standards (NBC 2005 [BIS 2005f]), layout and designing of interior and exterior facilities as per principles of universal design such as prescribed by the National Building Code of India, building management policies and procedures, provision of auxiliary aids and appliances, and staff training in disability awareness, and

• Comply with planning and design guidelines as outlined in NBC 2005 Annex D (Clause 12.21) (BIS 2005f)

XVII. Documentation

• Site plan showing staging and spill prevention measures, erosion and sedimentation control measures.

• Document to be submitted after completion of the project, a brief description along with photographic records to show that other areas have not been disrupted during construction. The document should also include brief explanation and photographic records to show erosion and sedimentation control measures adopted. (Document CAD drawing showing site plan details of existing vegetation, existing buildings, existing slopes and site drainage pattern, staging and spill prevention measures, erosion and sedimentation control measures and measures adopted for top soil preservation during construction).

• Site plan (one CAD drawing) along with a narrative to demarcate areas on site from which topsoil has to be gathered, designate area where it will be stored, measures adopted for topsoil preservation.

• Obtaining Certificate from landscape architect confirming proper protection and preservation of existing trees during construction process.

• Landscape plan, clearly highlighting the areas where trees were removed (indicating the number of trees), if applicable, with the number of replanted trees in the proportion of 1:3 in the proposed landscape design. List details about species, which existed, and the species that have been replanted on-site.

• Narrative explanation about the methods of soil stabilization used, wherever required, accompanied by photographs with brief description.

• Certificate by the landscape architect on topsoil laying, soil stabilization, and adequate primary soil nutrient and pH [(supported by test results performed at Indian Council of Agricultural Research (ICAR)-accredited laboratory].

• Contractor shall take regular photographs showing the health, safety and sanitation measure followed during construction and maintain the record of the same.

• Contractor shall submit the detailed narrative on provision for safe drinking water and sanitation facility for construction workers and site personnel accompanied by the photographs taken at regular intervals during construction.

• Contractor to submit the narrative (not more than 300 words) explaining the air pollution preventive measures that have been adopted on-site. Site photographs showing different stages of construction along with preventive measures to support of the same.
• Contractor to submit the narrative indicating the quantum of waste generated during construction and storage facility for segregated inert and hazardous waste before recycling and disposal accompanied by necessary documents and photographs.

• Contractor to submit the layout (showing the location & capacity) and photo of the storage facility for segregated inert and hazardous waste.

• Contractor to ensure that a plan is in place to ensure that more than 75% of the waste generated by weight or volume, on-site due to construction activities is either reused, recycled or sold as scrap and is diverted from going into landfills.

• Contractor to submit the proper records/documents in the form of logs, photographs, gate passes, hauler certificates, etc. for compliance of the same.

NOTE:

I. Scrap generated out of demolition to be dealt suitably in consultation with the state administrator/EPI and NTPC.

II. The items of civil/electrical & other works of schedule of items based on DSR shall be executed in accordance with the relevant latest CPWD specification/IS code with up to date corrections.

III. The items of civil/electrical & other works (Non DSR items) of schedule of items that are generally based on DSR, the CPWD specification shall be followed to the extent applicable. The non DSR items of work governed by the specification mentioned in the BOQ shall be performed as per technical specification, IS codes, Details shown in the BOQ shall be performed as per technical specification, IS codes. Details shown in the drawing, manufacturer’s specification and/or best available industrial practice.
LIST OF APPROVED MAKES
<table>
<thead>
<tr>
<th>S. no.</th>
<th>Item</th>
<th>Manufacturer's Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grey Cement (OPC 43 Grade)</td>
<td>ACC, Ultratech, JP, Ambuja</td>
</tr>
<tr>
<td>2</td>
<td>White Cement</td>
<td>J.K. Birla or equivalent</td>
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<tr>
<td>3</td>
<td>Reinforcement Steel (TMT bars)</td>
<td>Tata, sail, Rashtriya Ispat Nigam</td>
</tr>
<tr>
<td>4</td>
<td>Structural Steel sections</td>
<td>Sail, Vizag, Tata</td>
</tr>
<tr>
<td>5</td>
<td>Concrete Additives</td>
<td>Fosroc, Choksey, SikKa, STP</td>
</tr>
<tr>
<td>6</td>
<td>Anti termite Chemical</td>
<td>Pest Control India Ltd., Pest Con India, or Equivalent</td>
</tr>
<tr>
<td>7</td>
<td>Tile grouts, Joint Filler</td>
<td>Laticrete, Bal Endura, GE Bayer Silicon, STP</td>
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<tr>
<td>8</td>
<td>Polysulphide Sealant</td>
<td>Fosroc, Choksey, Pidilite, STP</td>
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<td>Silicone Sealant</td>
<td>GE Bayer Silicone, Dow Corning, Wacker</td>
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<td>Epoxy</td>
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<td>Admixture</td>
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<td>13</td>
<td>Formwork Release Agent</td>
<td>Choksey, MBT, BASF, STP</td>
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<td>14</td>
<td>Non Shrink grouts</td>
<td>Fosroc, SikKa, STP</td>
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<td>15</td>
<td>Non Metallic Floor Hardeners</td>
<td>Fosroc, Choksey, BASF, STP</td>
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<td>16</td>
<td>Bitumen</td>
<td>Shalimar tar products, Mathura oil refinery</td>
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<tr>
<td>17</td>
<td>Synthetic Enamel Paints</td>
<td>Berger, Nerolac, Asian, ICI Dulux</td>
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<tr>
<td>18</td>
<td>Oil Bound Distemper</td>
<td>Berger, Nerolac, Asian, ICI Dulux</td>
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<tr>
<td>19</td>
<td>Cement Paint</td>
<td>Snowcem Plus, Berger, Nerolac, STP</td>
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<td>20</td>
<td>Plastic Emulsion Paint</td>
<td>Berger, ICI, Nerolac, Asian</td>
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<tr>
<td>21</td>
<td>Other Paints &amp; Primer</td>
<td>ICI Dulux, Asian, Berger, Nerolac</td>
</tr>
<tr>
<td>22</td>
<td>Textured Coating/Paint</td>
<td>Heritage, Unitile, Spectrum</td>
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<td>23</td>
<td>Melamine</td>
<td>ICI Dulux, Timberstone Melamine Coating,</td>
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<td>24</td>
<td>Polyurethane Paint</td>
<td>MRF, Nerolac, Texfin</td>
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<tr>
<td>25</td>
<td>Silicon Water Repellent Solution</td>
<td>GE Bayer Silicon, Choksy chemicals, Bal Endura, BASF</td>
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<tr>
<td>26</td>
<td>Ceramic Tiles (Glazed, Matt, Others)</td>
<td>Kajaria, RAK. NITCO, Somany</td>
</tr>
<tr>
<td>27</td>
<td>Vitrified Tiles</td>
<td>Kajaria, Rak, NITCO, Somany</td>
</tr>
<tr>
<td>28</td>
<td>Laminated Wooden flooring</td>
<td>Pergo, Berry. Floor Master, Greenlam (Mikasa)</td>
</tr>
<tr>
<td>29</td>
<td>PVC/Vinyl Flooring</td>
<td>Polyflor, Ger Floor, Tarkett</td>
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<tr>
<td>30</td>
<td>Terrazzo Tile</td>
<td>NITCO, Unistone, Hindustan</td>
</tr>
<tr>
<td>31</td>
<td>Interlock Tiles, Grass Paver Block</td>
<td>Nimco Prefab, K K Manhole, Hindustan</td>
</tr>
<tr>
<td>32</td>
<td>Cement Concrete Tiles, Designer Tiles</td>
<td>Unistone, Dazzle, Eurocorn, .</td>
</tr>
<tr>
<td>33</td>
<td>Laminates &amp; veneers</td>
<td>Century, Greenply, Merino, Archidply, Greenlam</td>
</tr>
<tr>
<td>34</td>
<td>MDF Grade-I as per IS-12406&amp; Ecomark</td>
<td>Century, Greenply, Merino, Archidply</td>
</tr>
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<td>35</td>
<td>Adhesive for wood work</td>
<td>Dunlop, Fевicol,</td>
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<td>36</td>
<td>Pre Laminated Particle Board</td>
<td>Century, Greenply, Merino, Archidply, Greenlam</td>
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<tr>
<td>37</td>
<td>Plywood, Block Board, Soft Board</td>
<td>Century, Greenply, Merino, Archidply, Modiply</td>
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<tr>
<td>38</td>
<td>Paving Stones</td>
<td>Unistone, Nimco Prefab, K K Manhole, Hindustan</td>
</tr>
<tr>
<td>39</td>
<td>Wax Polish</td>
<td>Mansion, Reckitt &amp; Colman</td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
<td>Supplier Name</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------------------------</td>
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<tr>
<td>40</td>
<td>Polyethylene Sealant</td>
<td>MBT, Choksey, Fosroc, Pidilite, STP</td>
</tr>
<tr>
<td>41</td>
<td>Polyethelene Board, Back Up Rod</td>
<td>Supreme Industries or Equivalent</td>
</tr>
<tr>
<td>42</td>
<td>Stainless Steel Hinges</td>
<td>Hettich, Doorset, Godrej, Dorma, Hardwyn</td>
</tr>
<tr>
<td>43</td>
<td>Mirror &amp; Float Glass</td>
<td>Modi Float Glass, Asahi Glass, Saint Gobain</td>
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<tr>
<td>44</td>
<td>Door Hardware</td>
<td>Godrej, Doorset, Dorma, Hettich, Hardwyn</td>
</tr>
<tr>
<td>45</td>
<td>Furniture Hardware</td>
<td>Hettich, Blum, Hardwyn</td>
</tr>
<tr>
<td>46</td>
<td>Aluminum Building Expansion Joints</td>
<td>Vexcolt, Watson Bowman, Acme, Z- Tech India, JMetco</td>
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<tr>
<td>47</td>
<td>Water Stopper</td>
<td>Fixopan, Caliplast or equivalent</td>
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<td>48</td>
<td>Aluminium Composite Panel</td>
<td>Alucobond, Alstrong, Aludecor.</td>
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<tr>
<td>49</td>
<td>Asphalt Emulsion</td>
<td>STP, Karnak Chemical Corporation.</td>
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<tr>
<td>50</td>
<td>Expansion Fastener</td>
<td>Hilti, Fischer, Canon</td>
</tr>
<tr>
<td>51</td>
<td>Stainless Steel</td>
<td>Salem, Jindal, Cavelier</td>
</tr>
<tr>
<td>52</td>
<td>Anchor Fastener, Anchor Bolts</td>
<td>Hilti, Fischer, Canon</td>
</tr>
<tr>
<td>53</td>
<td>Gypsum Partition &amp; Gypsum Ceiling with frame</td>
<td>Saint Gobin, Boral, Lafarge, Vans</td>
</tr>
<tr>
<td>54</td>
<td>Impregnated Fibre Board</td>
<td>STP or equivalent</td>
</tr>
<tr>
<td>55</td>
<td>Joint Filler and Bitumen Products</td>
<td>STP or equivalent</td>
</tr>
<tr>
<td>56</td>
<td>Electrodes</td>
<td>Advani-Overlikon, ESAB, Dwekam</td>
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<tr>
<td>57</td>
<td>Mineral Fibre Ceiling System</td>
<td>Aura, AMF, USG, Decosonic</td>
</tr>
<tr>
<td>58</td>
<td>H.T. Bolts</td>
<td>Unbrako or equivalent</td>
</tr>
<tr>
<td>59</td>
<td>Steel Doors (General purpose)</td>
<td>Shakti Met-Dor or equivalent</td>
</tr>
<tr>
<td>60</td>
<td>Steel Doors (Fire rated)</td>
<td>Global Fire Protection Company, Radiant safe Fire Doors, Godrej, Navair, Shakti Met-Dor</td>
</tr>
<tr>
<td>61</td>
<td>Fire Door (Wooden)</td>
<td>Navair, Aadhunice, Radiant, Greenlam (Mikasa)</td>
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<tr>
<td>62</td>
<td>Aluminum Sections</td>
<td>Jindal, Hindalco, Indo Alusys</td>
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<tr>
<td>63</td>
<td>Rolling Shutter</td>
<td>Shivam, Milestones, Rama, Prakash</td>
</tr>
<tr>
<td>64</td>
<td>Pre-coated Roof Sheeting</td>
<td>Multicolor, BHP, Bluescope, Japan Metal Systems, Lloyds, CRIL</td>
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<tr>
<td>65</td>
<td>Glass wool and related products, Mineral wool</td>
<td>UP-Twiga, Owens Corning, Lloyds</td>
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<tr>
<td>66</td>
<td>Polycarbonate sheets</td>
<td>GE Plastics, Danpalon, Polygal</td>
</tr>
<tr>
<td>67</td>
<td>Self drilling Screws</td>
<td>Hilti, Builtext or equivalent</td>
</tr>
<tr>
<td>68</td>
<td>Logo, Signs, Name plates</td>
<td>D-Line, Sign Sutra, Sameer</td>
</tr>
<tr>
<td>69</td>
<td>Pre-engineered Building</td>
<td>Kirby Building, Tiger Steel or equivalent</td>
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<tr>
<td>70</td>
<td>Flush Doors</td>
<td>Merino, Greenlam, Century, Archidply, Modipy</td>
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<tr>
<td>71</td>
<td>MS Sliding Motorized Door</td>
<td>Shivam Associates - Benica RIS24 K System or equivalent</td>
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<tr>
<td>72</td>
<td>Water proofing compound</td>
<td>Pidilite, Cico, Fosroc, Choksey, Mapei</td>
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<tr>
<td>73</td>
<td>Fasteners</td>
<td>Gun, Atul, Hilti, Canon</td>
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<tr>
<td>74</td>
<td>Aluminum fittings</td>
<td>Crown, Nulite, Mccoy</td>
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<tr>
<td>75</td>
<td>Extruded vitrified clay tile</td>
<td>Duvtex, Unistone, Pioneer</td>
</tr>
<tr>
<td>76</td>
<td>POP</td>
<td>Sriram or equivalent</td>
</tr>
<tr>
<td>77</td>
<td>outdoor furniture (sitting bench, dustbin)</td>
<td>Arihant or equivalent</td>
</tr>
<tr>
<td>78</td>
<td>Modular furniture</td>
<td>Godrej, HNI, Featherlite</td>
</tr>
<tr>
<td>79</td>
<td>Chairs and Sofas</td>
<td>Godrej, HNI, Featherlite</td>
</tr>
<tr>
<td>80</td>
<td>Acoustical paneling</td>
<td>Absound overseas, Anutone, Armstrong</td>
</tr>
<tr>
<td>81</td>
<td>Modular Toilets</td>
<td>Merino, Dorma, Tresa, Strudro (Greenlam)</td>
</tr>
<tr>
<td>82</td>
<td>Mosaic tiles</td>
<td>Nitco, surya, Laxmi</td>
</tr>
<tr>
<td>83</td>
<td>Acoustical False Ceiling</td>
<td>Absound overseas, Anutone, Armstrong</td>
</tr>
<tr>
<td>No.</td>
<td>Material / Component</td>
<td>Brand/Model</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>84</td>
<td>Exterior tiles</td>
<td>Duvtex, Unistone, Pioneer</td>
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<tr>
<td>85</td>
<td>Patch Fitting/ Spider Fitting</td>
<td>D-Line, Hettich, Dorma, Hardwyn</td>
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<tr>
<td>86</td>
<td>UPVC Door &amp; Window</td>
<td>Fenesta or Equivalent</td>
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<tr>
<td>87</td>
<td>Acid and alkali resistant tiles</td>
<td>Kajaria, NITCO, Durato</td>
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<tr>
<td>88</td>
<td>Ceramic Rainscreen ventilated faced tile/Teracotta</td>
<td>Terrial, Soladrilho</td>
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<tr>
<td>89</td>
<td>Roller Blinds</td>
<td>Hunter Douglas / Mac/Vista</td>
</tr>
<tr>
<td>90</td>
<td>GRC Jali</td>
<td>Unistone, Birla GRC, Grasim</td>
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<tr>
<td>91</td>
<td>Metal Ceiling</td>
<td>Aura, Unimet, Hunter Douglas</td>
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<tr>
<td>92</td>
<td>Decking Sheet</td>
<td>Tata Bluescope Corus or equivalent</td>
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<td>93</td>
<td>Aluminium standing Seam roofing</td>
<td>Kalzip/Bemo/Sanko/Kingspan</td>
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<tr>
<td>94</td>
<td>Foam Concrete</td>
<td>Valifoom/ Salifoam/AE Foam</td>
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<tr>
<td>95</td>
<td>Expansion Joints</td>
<td>3R Joints &amp; seals, sandfield, vexcolt</td>
</tr>
<tr>
<td>96</td>
<td>Raised/False Access Flooring</td>
<td>Unifloor, Tate, Kingspan</td>
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<tr>
<td>97</td>
<td>Lifts</td>
<td>Kone, Otis, Mitsubishi, Schinder</td>
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<tr>
<td>98</td>
<td>Calcium Silicate False Ceiling</td>
<td>Aerolite, Armstrong (Mylar/Newtone)</td>
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<tr>
<td>99</td>
<td>&quot;T&quot; Grid For calcium Silicate False Ceiling</td>
<td>RK, Grid System, Gridline</td>
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<tr>
<td>100</td>
<td>Portland Slag Cement</td>
<td>ACC, Ultraceh, JP, Ambuja, OCL (Konark brand)</td>
</tr>
<tr>
<td>101</td>
<td>Portland Pozzolana Cement (Flyash)</td>
<td>ACC, Ultraceh, JP, Ambuja, OCL (Konark brand)</td>
</tr>
</tbody>
</table>

**ELECTRICAL**

**A. ELECTRICAL HIGH SIDE EQUIPMENT**

1. UPS SYSTEM                       | EMERSON/3 M POWER / SOCOMAC
2. INVERTOR                         | LUMINOUS / MATRIX / SU-KAM

**B. ELECTRICAL SYSTEM/PANELS**

1. FUSES & SWITCH FUSE UNIT         | L&T/ ABB/ SCHNEIDER/ GE
2. ACB / MCCB / CONTACTOR          | L&T/ ABB/ SCHNEIDER/ GE
3. METAL CLAD SOCKET               | SIEMENS/ MDS/ BHARTIA CUTLUR HAMMER/MENNEKES
4. RISING MAINS / BUS DUCT          | TRICOLITE INDUSTRIES / SPC ELECTROTECH / ADLEC / SCHNEIDER / C&S/ ABB/ADVANCE PANEL & SWITCHGEAR
5. LED'S LIGHT                      | PHILIPS/ WIPRO/BAJAJ/HPL
6. ISOLATORS FOR MOTORS             | MDS/ SIEMENS/ SCHNEIDER/ ABB/GE
7. CHANGE OVER SWITCH              | HH-ELCON/ HPL / GE
8. CONTACTOR, TIMER, SINGLE PHASE PREVENTOR & OVER LOAD RELAY | L&T/ ABB/ SCHNEIDER/ GE/ OMRON
9. METERS - DIGITAL TYPE            | AE/ L&T/ RISHAB/ GE
10. PROTECTIVE & APFC RELAYS        | ASLTOM/ ASHIDA/ L&T
11. CT's / PT's- DRY TYPE-EPOXY     | AE/ KAPPA
12. INDICATING LAMP / PUSH BUTTON ACTUATORS - LED CLUSTER TYPE | L&T/ SIEMENS/ / OMRON
13. ROTARY SWITCHES                 | L&T/ KAYCEE/ BCH
14. TERMINAL BLOCK                  | ELEMEX/ WAGO
15. LT PANELS                       | TRICOLITE INDUSTRIES / SPC ELECTROTECH / ADLEC / SCHNEIDER ELECTRIC/ C&S/ ABB/ADVANCE PANEL & SWITCHGEAR
16. LIGHTNING ARRESTER              | ERICO/ ESE
17. GAS FIRE SUSPERSION SYSTEM      | FIRE LINE/ TYCO FIRE
### C. CABLES/ TERMINATIONS/ ACCESSORIES

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Brands</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>LUGS</td>
<td>DOWELS/ COMET</td>
</tr>
<tr>
<td>2</td>
<td>BRASS CABLE GLANDS</td>
<td>COMMET/ BELIGA</td>
</tr>
<tr>
<td>3</td>
<td>LT POWER CABLE (ALUMINIUM/ COPPER)</td>
<td>UNIVERSAL/ NICCO/ POLYCA/K  SKYTONE/HAVELLS</td>
</tr>
<tr>
<td>4</td>
<td>CONTROL CABLE (COPPER)</td>
<td>UNIVERSAL/ NICCO/ POLYCA/K  SKYTONE/HAVELLS</td>
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<tr>
<td>5</td>
<td>HT XLPE CABLE</td>
<td>UNIVERSAL / RPG CABLE / NICCO/SKYTONE</td>
</tr>
<tr>
<td>6</td>
<td>H.T. CABLE END TERMINATION</td>
<td>BIRLA 3 M/ REYCHEM/ FRONTEC</td>
</tr>
<tr>
<td>7</td>
<td>Fire Survival Cable</td>
<td>AFW FRTEK PRYSMIAN BELDEN</td>
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</table>

### D. CONDUITING & WIRING ACCESSORIES

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<th></th>
<th>Description</th>
<th>Brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MS CONDUIT / GI CONDUIT (ISI MARKED)</td>
<td>BEC/ POLYPACK/ AKG/ATUL</td>
</tr>
<tr>
<td>2</td>
<td>PVC CONDUIT (ISI MARKED)</td>
<td>BEC/ POLYPACK/ AKG /ATUL</td>
</tr>
<tr>
<td>3</td>
<td>PVC INSULATED COPPER CONDUCTOR</td>
<td>FINOLEX / HAVELLS/ SKYTONE</td>
</tr>
<tr>
<td>4</td>
<td>PLATE TYPE - SWITCHES / SOCKETS / TV &amp; TELEPHONE SOCKETS AND ALL OTHER WIRING ACCESSORIES</td>
<td>M.K/ LEGRAND/ ANCHOR-ROMA//MENNEKES (polycarbonate)</td>
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<tr>
<td>5</td>
<td>ACCESSORIES FOR METALIC / GI CONDUIT ( ISI MARKED )</td>
<td>SHRMA STEEL CORPORATION / PRAKASH ENGINEERING WORKS / SUPER SALES CORPORATION</td>
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<tr>
<td>6</td>
<td>PVC INSULATION TAPE</td>
<td>STEEL GRIP/ ANCHOR</td>
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<tr>
<td>7</td>
<td>PHENOL LAMINATED SHEET</td>
<td>HYLUM/ FORMICA</td>
</tr>
<tr>
<td>8</td>
<td>RACEWAYS &amp; CABLE TRAY</td>
<td>CTM ENGG/SWIFT/OBO BEHERMAN /BEC</td>
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### E. LIGHTING DBs & MCBs

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<th>Description</th>
<th>Brands</th>
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<tr>
<td>1</td>
<td>MCB, 10KA</td>
<td>ABB/ GE/ HAGER/ MERLIN GERIN/HPL.</td>
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<tr>
<td>2</td>
<td>DISTRIBUTION BOARD</td>
<td>MDS/ L&amp;T/ EATON/HPL</td>
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<tr>
<td>3</td>
<td>ELCB / ELMCB / RCCB</td>
<td>MDS/ GE/ HAGER/ MERLIN GERIN/HPL</td>
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### F. LIGHTING FIXTURES & FANS

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<tbody>
<tr>
<td>1</td>
<td>BULK HEAD FITTINGS</td>
<td>BAJAJ/ CROMPTON/ PHILIPS</td>
</tr>
<tr>
<td>2</td>
<td>EXHAUST FANS / CEILING FAN / WALL MOUNTED FAN</td>
<td>CROMPTON/ POLAR/ ALMONARD/KHAITAN</td>
</tr>
<tr>
<td>3</td>
<td>LIGHTING FIXTURES</td>
<td>PHILIPS/ BAJAJ/ WIPRO/HPL/DECON Lighting Pvt. Ltd.</td>
</tr>
<tr>
<td>4</td>
<td>LIGHTING CONTROL SYSTEM</td>
<td>SCHNIDER/ PHILIPS/ LUTRON</td>
</tr>
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</table>

### G. ELV- TELEPHONE/ CCTV/ DOOR ACCESS/ FIRE ALARM/ PUBLIC ADDRESS & MISC. SYSTEMS

<table>
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<tr>
<th></th>
<th>Description</th>
<th>Brands</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>SMOKE DETECTORS</td>
<td>NOTIFIER/ HONEYWELL(Eclipse series )/ Ansul (Tyco)/COOPER</td>
</tr>
<tr>
<td>2</td>
<td>HEAT DETECTORS</td>
<td>NOTIFIER/ HONEYWELL(Eclipse series )/ Ansul (Tyco)/COOPER</td>
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<tr>
<td>3</td>
<td>MANUAL CALL BOX</td>
<td>NOTIFIER/ HONEYWELL(Eclipse series )/ Ansul</td>
</tr>
<tr>
<td>No.</td>
<td>Item</td>
<td>Supplier</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>4</td>
<td>HOOTER/ SOUNDER</td>
<td>NOTIFIER/ HONEYWELL(Eclipse series )/ Ansul (Tyco)/COOPER</td>
</tr>
<tr>
<td>5</td>
<td>RESPONSE INDICATOR</td>
<td>Sterling wilson /Tyco/Agni/Sudhir</td>
</tr>
<tr>
<td>6</td>
<td>FIRE PANEL</td>
<td>NOTIFIER/ HONEYWELL(Eclipse series )/ Ansul (Tyco)/COOPER</td>
</tr>
<tr>
<td>7</td>
<td>PA AMPLIFIER</td>
<td>Bosch EV / Paso / Digiton</td>
</tr>
<tr>
<td>8</td>
<td>PA SPEAKERS</td>
<td>Bosch EV / Paso / Digiton</td>
</tr>
<tr>
<td>9</td>
<td>LINE MATCHING TRANSFORMER</td>
<td>Bosch EV / Paso / Digiton</td>
</tr>
<tr>
<td>10</td>
<td>GOOSE NECK MIKE</td>
<td>Bosch EV / Paso / Digiton</td>
</tr>
<tr>
<td>11</td>
<td>INVERTER</td>
<td>TOPAZ INTERNATIONAL/ LUMINOUS/ HYTES</td>
</tr>
<tr>
<td>12</td>
<td>CAMERA WITH ALL ACCESSORIES</td>
<td>HONEYWELL /PELCO/BOSCH</td>
</tr>
<tr>
<td>13</td>
<td>ROAD BARRIER</td>
<td>NICE/ MAGNETICS/ GODREJ/ GE</td>
</tr>
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<td>14</td>
<td>CARD READER</td>
<td>SENSORMATIC-USA/ MOTOROLA /HONEYWELL(XLS-3000)</td>
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<td>15</td>
<td>MONITOR</td>
<td>LG / SAMSUNG/SONY</td>
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<td>16</td>
<td>MULTIPLEXER</td>
<td>SENSORMATIC OR EQUIVALENT</td>
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<td>17</td>
<td>SEQUENCER</td>
<td>ALBA/ VANTAGE</td>
</tr>
<tr>
<td>18</td>
<td>PROXIMITY CARD</td>
<td>MOTOROLA/ HUGHES/ HONEYWELL/GE/SIEMENS</td>
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<td>19</td>
<td>TELEPHONE TAG BLOCK</td>
<td>CTM ENGG/SYSTIMAX/SCHNEIDER/PANDUIT</td>
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<tr>
<td>20</td>
<td>TELEPHONE CABLES</td>
<td>DELTON / SKYтон/ CLIPSAL</td>
</tr>
<tr>
<td>21</td>
<td>CO-AXIAL CABLES</td>
<td>FINOLEX/ DELTON/SKYTON</td>
</tr>
<tr>
<td>22</td>
<td>EPABX</td>
<td>AЛKATEL/ SIEMENS/ NORTEL</td>
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<tr>
<td>23</td>
<td>CCTV SYSTEM</td>
<td>HONEYWELL/ SIEMENS /PELCO</td>
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<tr>
<td>24</td>
<td>IT &amp; TELECOM SYSTEM</td>
<td>SCHNEIDER/ SYSTIMAX/ PANDUIT</td>
</tr>
<tr>
<td>25</td>
<td>FIRE ALARM SYSTEM</td>
<td>NOTIFIER/ HONEYWELL(Eclipse series )/ Ansul (Tyco)/COOPER</td>
</tr>
<tr>
<td>26</td>
<td>ACCESS CONTROL SYSTEM</td>
<td>HONEYWELL/ SIEMENS/GE</td>
</tr>
<tr>
<td>27</td>
<td>Fire Survival Cable</td>
<td>AFW FRTEK PРYSMIAN BELDEN</td>
</tr>
<tr>
<td>28</td>
<td>Feedback Suppressor</td>
<td>Bosch EV / Paso / Digiton</td>
</tr>
<tr>
<td>29</td>
<td>Mixer Band Equalizer</td>
<td>Bosch Dynacord / Paso / Digiton</td>
</tr>
<tr>
<td>30</td>
<td>Projector</td>
<td>Barco/ Viviтек / Christie</td>
</tr>
<tr>
<td>31</td>
<td>Ceiling mounting kit for projector</td>
<td>Draper /Red Leaf / Suvira</td>
</tr>
<tr>
<td>32</td>
<td>Fixed screen</td>
<td>Draper /Red Leaf / Suvira</td>
</tr>
</tbody>
</table>

H. MISCELLANEOUS SYSTEMS

1. BATTERIES | EXIDE/ STANDARD |
2. BATTERY CHARGER | KELTRON/ NELCO/ EXIDE/ HBL NIFE |
3. EARTHING (ALL TYPE) | Nutech Products, Mahavir Industrial Corporation, Pranav Energy. |

I. DG/PANEL/TRANSFORMER

1. ALTERNATOR | STAMFORд/ CATERPILLAR/ KИRLOSKER/СROMPTON |
2. ENGINE | CUMMINS/ CATERPILLAR/ KИRLOSKER |
3. HT PANELS | ABB/ GE/SPC ELECTROТЕCH |
4. TRANSFORMER | VOLTAMP/ ABB/ AREVA / KИRLOSKER/SUDHIR |
5. UNITISED / COMPACT SUB-STATION | ABB/SIEMENS/ SCHNIEDER/SUDHIR |
<table>
<thead>
<tr>
<th><strong>PLUMBING SYSTEM</strong></th>
<th><strong>PARRYWARE, ROCA, HINDWARE / JAQUAR</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 VITREOUS CHINA SANITARYWARE</td>
<td><strong>PARRYWARE, ROCA, HINDWARE / JAQUAR</strong></td>
</tr>
<tr>
<td>2 PLASTIC W.C. SEATS &amp; COVERS</td>
<td><strong>PARRYWARE, ROCA, HINDWARE / JAQUAR</strong></td>
</tr>
<tr>
<td>3 C.P. FITTINGS: BIB COCK (LONG BODY/SHORT BODY), PILLAR COCK, SINGLE HOLE BASIN MIXTURE, WALL MIXER, SHOWER MIXER, ANGLE VALVE, CONCEALED STOP COCK, SHOWER WITH WALL FLANGE, C.P. WASTE 32-40 mm DIA, BOTTLE TRAP, HEALTH FAUCET WITH STEEL BEDED CONNECTING PIPE.</td>
<td><strong>JAQUAR / ESS ESS / GROHE / HINDWARE / PARKO / PLAYER / PRAYAG</strong></td>
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<tr>
<td>4 AUTOMATIC WATER TAPS, AUTOMATIC URINAL FLUSHING SYSTEM</td>
<td><strong>JAQUAR / ESS ESS / GROHE / HINDWARE / PARKO / PLAYER / PRAYAG</strong></td>
</tr>
<tr>
<td>5 TOWEL RING, TOWEL ROD, TOWEL RACK, COAT HOOK etc. (304 Grade S.S.)</td>
<td><strong>JAQUAR / ESS ESS / GROHE / HINDWARE / PARKO / PLAYER / PRAYAG</strong></td>
</tr>
<tr>
<td>6 CHROMIUM PLATED / STAINLESS STEEL / POLY VENIEL CHLORIDE GRATING</td>
<td>Cummun, Neer, Chilly / PRAYAG</td>
</tr>
<tr>
<td>7 STAINLESS STEEL SINK</td>
<td><strong>JAINA / NEELKANT / ANUPAM / PRAYAG</strong></td>
</tr>
<tr>
<td>8 SAND CAST IRON SPUN PIPE, CENTIFUGALLY CASTED S &amp; S AS PER IS: 3989</td>
<td><strong>NECO / RAJ IRON FOUNDRY / RIF / SKF</strong></td>
</tr>
<tr>
<td>9 CAST IRON PIPE, HORIZONTALLY / VERTICALLY CASTED S &amp; S AS PER IS: 1729</td>
<td><strong>NECO / RAJ IRON FOUNDRY / RIF / SKF</strong></td>
</tr>
<tr>
<td>10 G.I. &amp; M.S. PIPES PART-I IS: 1239 UPTO 150 mm AND M.S. PIPES PART-II IS: 3589 ABOVE 150 mm</td>
<td><strong>TATA STEEL (TUBE DIVISION) / JINDAL PIPES LIMITED</strong></td>
</tr>
<tr>
<td>11 G.I. AND M.S. FITTINGS</td>
<td><strong>UNIQUE / ZOLOTTO / KENT</strong></td>
</tr>
<tr>
<td>12 uPVC PIPES &amp; FITTINGS 4 kg./sqm, 6 kg./sqm, 10 kg./sqm PRESSURE.</td>
<td><strong>SUPREME INDUSTRIES LIMITED / FINOLEX INDUSTRIES / PRINCE PIPES &amp; FITTINGS PRIVATE LIMITED</strong></td>
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<tr>
<td>13 cPVC PIPES SDR12.5 SCHEDULE-40</td>
<td><strong>ASTRAL POLYTECHNIC PRIVATE LIMITED / ASHIRVAD ENTERPRISES PRIVATE LIMITED / JAIN PLASTICS &amp; CHEMICALS LIMITED / FINOLEX INDUSTRIES / PRAYAG</strong></td>
</tr>
<tr>
<td>14 HDPE PIPE</td>
<td><strong>JAIN PLASTICS &amp; CHEMICALS LIMITED / CHEMI PLAST INDUSTRIES STUROY POLYMERS LIMITED / KISAN GROUP OF COMPANIES / FINOLEX INDUSTRIES / BEC</strong></td>
</tr>
<tr>
<td>15 C.I. CLASS LA PIPES</td>
<td><strong>KESORMA SPUN PIPE &amp; FOUNDRIES, CALCUTTA / SUPER ENTERPRISES / INDIAN IRON &amp; CO. LTD. CALCUTTA.</strong></td>
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<tr>
<td>16 R.C.C. PIPES</td>
<td><strong>PRAGATI CONCRETE UDYOG / K.K. SPUN PIPES / J.K. SPUN PIPES / SOOD &amp; SOOD</strong></td>
</tr>
<tr>
<td>17 STONEWARE PIPES &amp; GULLY TRAP</td>
<td><strong>DEVRAJ ANAND CERAMIC (P) LIMITED / PERFECT POTTERI JABALPUR (MP) / BURN POTTERIES, JABALPUR</strong></td>
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<tr>
<td>18 GUNMETAL VALVES (FULLWAY, CHECK, GLOBE AND NON RETURN VALVES)</td>
<td><strong>LEADER VALVES LIMITED / ARKAY SALSE CORPORATION DELHI</strong></td>
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<tr>
<td>19 BALL VALVE</td>
<td><strong>TBS ENGINEERS PVT. LTD / VIRGO ENGINEERING LTD / GOOJARMAL GANPATRAI / AUDCO INDIA LIMITED</strong></td>
</tr>
<tr>
<td>20 BUTTERFLY VALVE (LEVER TYPE)</td>
<td><strong>LEADER VALVES LIMITED / CASTLE VALVES LIMITED / AUDCO INDIA LIMITED</strong></td>
</tr>
<tr>
<td>21 BUTTERFLY VALVE (GEAR TYPE)</td>
<td><strong>LEADER VALVES LIMITED / CASTLE VALVES LIMITED / AUDCO INDIA LIMITED / GOOJARMAL GANPATRAI</strong></td>
</tr>
<tr>
<td>22 C.I. DOUBLE FLANGED SLUICE VALVE &amp;</td>
<td><strong>KIRLOSKAR BROTHERS LIMITED / AARKO</strong></td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
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<tr>
<td>23</td>
<td>FLOAT VALVE (GUNMETAL) UPTO 40M</td>
</tr>
<tr>
<td>24</td>
<td>FLOAT VALVE (CI) 50M AND ABOVE</td>
</tr>
<tr>
<td>25</td>
<td>FOOT VALVE / CHECK VALVES (BRASS)</td>
</tr>
<tr>
<td>26</td>
<td>AIR RELEASE VALVES (BRASS / CAST IRON)</td>
</tr>
<tr>
<td>27</td>
<td>C.I. MANHOLES COVER &amp; G.I. GRATING</td>
</tr>
<tr>
<td>28</td>
<td>HAND DRIER (304 Grade S.S.)</td>
</tr>
<tr>
<td>29</td>
<td>LIQUID SOAP DISPENSER (304 Grade S.S.)</td>
</tr>
<tr>
<td>30</td>
<td>STORAGE TYPE WATER HEATER</td>
</tr>
<tr>
<td>31</td>
<td>INSULATION</td>
</tr>
<tr>
<td>32</td>
<td>SOLAR HOT WATER EQUIPMENT</td>
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<tr>
<td>33</td>
<td>ELECTRICAL HOT WATER HEATER</td>
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<tr>
<td>34</td>
<td>PVC FOOT REST &amp;SFRC COVERS</td>
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**PUMPS AND EQUIPMENTS**

<table>
<thead>
<tr>
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<th>Item Description</th>
<th>Manufacturing Company/ Engineering Company</th>
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<tbody>
<tr>
<td>1</td>
<td>WATER TRANSFER PUMPS</td>
<td>ABB/ GROUNDFOS/ KIRLOSKAR/ SIEMENS/ CROMPTON</td>
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<td>2</td>
<td>IRRIGATION PUMP</td>
<td>GROUNDFOS/ KIRLOSKAR</td>
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<td>SUMP PUMP</td>
<td>SALMON/ ZENIT/ KSB/ GROUNDFOS</td>
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<td>WATER LEVEL INDICATOR</td>
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<td>WATER LEVEL CONTROLLER</td>
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<td>ELECTRONIC SENSING PROBE</td>
<td>ADVANCE OR EQUIVALENT</td>
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<td>7</td>
<td>CHLORINATOR</td>
<td>ASIA LMI Pvt. Ltd/ TOSHNIWAL</td>
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<td>WATER METER</td>
<td>CRESENT/ KAYEE/ KAPSTAN/ ANAND AASHI</td>
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<td>SOUNDER PATTERN VALVE FOR FILTER AND SOFTENER</td>
<td>LABLINE/ AIP (AGRICULTURE AND INDUSTRIAL PUMPS.</td>
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<tr>
<td>10</td>
<td>PRESSURE GAUGE</td>
<td>FIEBIG/ H. GURU</td>
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<td>NON RETURN VALVE (65mm DIA &amp; ABOVE)</td>
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<td>BUTTERFLY VALVE (LEVER TYPE)</td>
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<td>BUTTERFLY VALVE (GEAR TYPE)</td>
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<td>FILTER AND SOFTENER</td>
<td>THERMAX/ WATCON/ BHARTIYA TECHNO CRAFT/ MIGRANI</td>
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<td>16</td>
<td>MOTORIZED VALVE</td>
<td>DANFOSS/ HONEYWELL</td>
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<td>VIBRATION PAD</td>
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<td>ELECTRIC DRIVEN MOTOR AND PUMPS</td>
<td>GRUNDFOS / MATHER PLATT / EBARA / WILO / EMU / DP</td>
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<td>ELECTRIC DRIVEN MOTOR AND PUMPS (INDIAN STANDARD)</td>
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<td>DIESEL ENGINE</td>
<td>KIRLOSKAR / ASHOK LEYLAND / CUMMINS</td>
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<td>G.I. AND M.S. PIPES</td>
<td>TATA / JINDAL HISAR / PRAKASH</td>
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<td>FIRE HOSE PIPES / R R.L. HOSE PIPE</td>
<td>NEWAGE / CRC / PADMINI / G. TECH / INDIAN RAYON. / SUPEREME</td>
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<td>FIRST AID FIRE HOSE REEL WITH BRACKET, DRUM AND NOZZLE</td>
<td>JYOTI / TIGER / PADMINI</td>
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<td>G.I. AND M.S. FITTINGS</td>
<td>KS / UNIK / DRP / ZOLOTO</td>
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<td>C.I. DOUBLE FLANGED SLUICE / GATE VALVE / NON-RETURN VALVES</td>
<td>H.SARKAR / KIRLOSKAR / SANT / LEADER / KALPANA / KARTAR</td>
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<td>SLIM SEAL BUTTERFLY VALVES (PN-1.6)</td>
<td>AUDCO / SANT / C&amp;R / KSB / INTERVALVE / CASTLE / ARROW</td>
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<td>C. I. BODY BUTTERFLY VALVE</td>
<td>AUDCO / SANT / INTERVALVE / CASTLE / ARROW / DANFOSS</td>
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<td>GUN METAL BODY BUTTERFLY VALVE</td>
<td>AUDCO / SANT / INTERVALVE / CASTLE / ARROW / DANFOSS</td>
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<td>TYCO / GRINNEL / KIDDE / CENTRAL / GTECH</td>
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<td>WRAPPING AND COATING</td>
<td>PYPECOAT / 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 (GUN METAL / BRASS / COPPER &amp; BRASS / ALUMINIUM)</td>
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<td>18</td>
<td>FIRE BRIGADE CONNECTION</td>
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<td>JATPEE / GRANDPRIT / DASHMESH</td>
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<td>RESISTOFLEX / KHANWAL / D. WREN</td>
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<td>SINGLE PHASING PREVENTOR (CURRENT OPERATED)</td>
<td>L &amp; T / SIEMENS / MINILEC</td>
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<td>FLOW METER</td>
<td>SCIENTIFIC EQUIPMENT. (P) LTD. SHALI BANDA HYDERABAD – 500263</td>
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<td>ELECTRICAL SWITCHGEAR &amp; STARTERS</td>
<td>SIEMENS / L &amp; T / ABB</td>
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<td>CABLES</td>
<td>SKYTONE / GLOSTER / NICCO / ASIAN / (RPG) UNIVERSAL / POLY CAB</td>
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<td>FLOW SWITCH</td>
<td>POTTER / SYSTEM SENSOR / JHONSON CONTROL</td>
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<td>SPC ELECTROTECH/ABB/SCHNEIDER/EATON</td>
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<td>ANNUNCIATION PANEL FOR SPRINKLER SYSTEM</td>
<td>PCD / SAFEWAY / AGNI (INDIA)</td>
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<td>32</td>
<td>ALARM VALVE &amp; HYDRAULIC ALARM</td>
<td>MATHER &amp; PLATT / HD</td>
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<td><strong>MOTOR WITH COVERING</strong></td>
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<td>THIMBLES / FERRULES (TINNED COPPER)</td>
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<td>CABLE GLANDS</td>
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<td>POWER CAPACITOR</td>
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<td>37</td>
<td>MEASURING METER (DIGITAL)</td>
<td>L&amp;T / SIEMENS / AE / ENERCON</td>
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<tr>
<td>38</td>
<td>DASH FASTENER</td>
<td>HILTI / FISHER</td>
</tr>
<tr>
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<td>PAINT PRIMERS</td>
<td>ASIAN / JENSON NICHOLSON</td>
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<td>PIPE HANGERS</td>
<td>CHILLY / GMGR</td>
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<td>42</td>
<td>MCB, DBs</td>
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<td>CARRIER/ TRANE/McQUAY/YORK</td>
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<td>CARYAIRE / ZECO / EDGETECH / ETHOS /MAPRO/VOLTAS/BLUESTAR</td>
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<td>AIR WASHER UNIT</td>
<td>ZECO / ROOTS / EDGETECH / WAVES / AMBASSADOR/SK SYSTEM</td>
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<td>PUMPING SET (CONSTANT SPEED)</td>
<td>BEACON / KSB / KIRLOSKAR / MATHER &amp; PLATT</td>
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<td>PUMPING SET (VARIABLE SPEED)</td>
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<td>KRUGER / FLAKT / NICOTRA/CB DOCTOR/SK SYSTEM</td>
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<td>BALL VALVE</td>
<td>RAPID CONTROL / ZOLOTO / GG / LEADER</td>
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<td>GUN METAL GATE VALVE</td>
<td>LEADER / ZOLOTO</td>
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<tr>
<td>---</td>
<td>-----------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td>AUTO AIR VENT</td>
<td>RAPID CONTROL / ANERGY</td>
</tr>
</tbody>
</table>

**C. DUCTS, GRILLS, DIFFUSERS & DAMPERS:**

<table>
<thead>
<tr>
<th></th>
<th>GSS FOR SITE FABRICATED DUCT</th>
<th>SAIL / TATA / NIPPON / BHUSHAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FIRE / SMOKE DAMPER</td>
<td>CARYAIRE / MAPRO / RAVISTAR</td>
</tr>
<tr>
<td>2</td>
<td>GRILLE, DIFFUSER &amp; DAMPERS</td>
<td>RAVISTAR / CARYAIRE / DYNACRAFT/MAPRO</td>
</tr>
<tr>
<td>3</td>
<td>SOUND ATTENUATORS</td>
<td>RAVISTAR / CARYAIRE / KRUGER /MAPRO</td>
</tr>
<tr>
<td>4</td>
<td>ANCHOR FASTENERS</td>
<td>HILTI / FISCHER</td>
</tr>
</tbody>
</table>

**D. INSULATION**

<table>
<thead>
<tr>
<th></th>
<th>GLASS WOOL, FIBER GLASS</th>
<th>UP TWIGA / OWENS CORNING / KIMMCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FRP TISSUE</td>
<td>UP TWIGA ,INSU SOUND /ARMA SOUND</td>
</tr>
<tr>
<td>2</td>
<td>EXPANDED POLYSTYRENE</td>
<td>BEARDELL / PR PACKAGING / CAPRICON</td>
</tr>
<tr>
<td>3</td>
<td>FR CLOSED CELL CROSSSED LINKED PE</td>
<td>Thermobreak /Trocellene / SUPREME</td>
</tr>
<tr>
<td>4</td>
<td>PUF PIPE SUPPORT</td>
<td>MALLANPUR TECH / BEST PLASTRONICS / LLOYD</td>
</tr>
<tr>
<td>5</td>
<td>CFRX COMPOUND</td>
<td>SHALIMAR / ASIAN</td>
</tr>
<tr>
<td>6</td>
<td>PROTECTIVE COATING OVER INSULATION</td>
<td>PARAMOUNT POLYTREAT</td>
</tr>
<tr>
<td>7</td>
<td>EXTRUDED POLYSTYRENE</td>
<td>SUPREME/ISOBOARD/DOW</td>
</tr>
</tbody>
</table>

**E. ELECTRICAL ITEMS**

<table>
<thead>
<tr>
<th></th>
<th>ELECTRICAL MOTORS</th>
<th>SIEMENS / ABB / CROMPTON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LED LIGHT</td>
<td>ARTLITE / COLOUR DESIGN / FIBRE LITE / THORN</td>
</tr>
<tr>
<td>2</td>
<td>FUSES &amp; SWITCH FUSE UNIT</td>
<td>SIEMENS/ ABB/ SCHNEIDER / GE / L &amp; T</td>
</tr>
<tr>
<td>3</td>
<td>ACB / MCCB / CONTACTOR</td>
<td>SIEMENS / ABB / SCHNIDER / GE / L &amp; T</td>
</tr>
<tr>
<td>4</td>
<td>METAL CLAD SOCKET</td>
<td>MDS / NEPTUNE (BALS) / BCH</td>
</tr>
<tr>
<td>5</td>
<td>ISOLATORS FOR MOTORS</td>
<td>MDS/ SIEMENS/ L &amp; T</td>
</tr>
<tr>
<td>6</td>
<td>CHANGE OVER SWITCH</td>
<td>HH-ELCON / HPL / GE / HAVELLS</td>
</tr>
<tr>
<td>7</td>
<td>CONTACTOR, TIMER, SINGLE PHASE PREVENTOR &amp; OVER LOAD RELAY</td>
<td>SIEMENS / ABB / GE / L &amp; T</td>
</tr>
<tr>
<td>8</td>
<td>METERS - DIGITAL TYPE</td>
<td>CONSERVE / AE / L &amp; T / RISHAB</td>
</tr>
<tr>
<td>9</td>
<td>PROTECTIVE &amp; APFC RELAYS</td>
<td>SIEMENS / GE / L &amp; T / ASLTOM</td>
</tr>
<tr>
<td>10</td>
<td>CT's / PT's- DRY TYPE-EPOXY</td>
<td>AE / KAPPA / PRAGATI</td>
</tr>
<tr>
<td>11</td>
<td>INDICATING LAMP / PUSH BUTTON ACTUATORs - LED CLUSTER TYPE</td>
<td>SIEMENS / L &amp; T / BCH / GE</td>
</tr>
<tr>
<td>12</td>
<td>ROTARY SWITCHES</td>
<td>L &amp;T / / BCH / GE / KAYCEE</td>
</tr>
<tr>
<td>13</td>
<td>TERMINAL BLOCK</td>
<td>ELEMEX / WAGO</td>
</tr>
<tr>
<td>14</td>
<td>LT ELECTRICAL PANEL BOARDS</td>
<td>ABB/ SCHNEIDER /EATON</td>
</tr>
<tr>
<td>15</td>
<td>CABLE TRAYS</td>
<td>CTM ENGG/SWIFT/OBO BEHERMAN</td>
</tr>
<tr>
<td>16</td>
<td>PVC INSULATED Copper CONDUCTOR FRLS Wire</td>
<td>FINOLEX / POLYCA/B / SKYTONE / HAVELLS/ DELTON</td>
</tr>
<tr>
<td>17</td>
<td>PVC INSULATION TAPE</td>
<td>STEEL GRIP/ ANCHOR</td>
</tr>
<tr>
<td>18</td>
<td>SINGLE PHASE EXHAUST FAN</td>
<td>CROMPTON / KHATAN / GEC / POLAR / ALMONARD</td>
</tr>
<tr>
<td>19</td>
<td>LT POWER / CONTROL CABLES</td>
<td>FINOLEX / POLYCA/B / SKYTONE / DELTON / GRANDLAY</td>
</tr>
</tbody>
</table>

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Page 456
**F. MISCELLANEOUS:**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Models/Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Duct Silencer</td>
<td>CARYAIRE / KRUGER</td>
</tr>
<tr>
<td>2</td>
<td>Duct Temperature Sensor</td>
<td>HONEYWELL / SIEMENS / JOHNSON / RANCO</td>
</tr>
<tr>
<td>3</td>
<td>Vibration Isolator</td>
<td>RAPID CONTROL / ANERGY</td>
</tr>
<tr>
<td>4</td>
<td>Water Flow Switch, Airstat</td>
<td>RESISTOFLEX / EMERALD</td>
</tr>
<tr>
<td>5</td>
<td>Packaged Units</td>
<td>Trane/Daikin/Toshiba/Hitachi</td>
</tr>
<tr>
<td>6</td>
<td>Ductable/Hi Wall Units</td>
<td>Trane/Daikin / Hitachi /Carrier</td>
</tr>
<tr>
<td>7</td>
<td>Volume Control Damper</td>
<td>Air Track Control/ HPS/ Caryaire /System Air</td>
</tr>
<tr>
<td>8</td>
<td>Damper Actuator</td>
<td>Siemens/ Honeywell/ Dynacraft</td>
</tr>
<tr>
<td>9</td>
<td>Acoustic Lining (Fiber Glass)</td>
<td>Beardsell/UP Twiga /Owens Corning/Lloyed</td>
</tr>
<tr>
<td>10</td>
<td>Self Adhesive Sealing Gasket for ducts</td>
<td>Self Adhesive Sealing Gasket for ducts</td>
</tr>
</tbody>
</table>

**BUILDING MANAGEMENT SYSTEM**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Models/Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building Management System</td>
<td>HONEYWELL WEBS / SIEMENS / CARRIER ALC</td>
</tr>
<tr>
<td>2</td>
<td>Immersion Temperature Sensor</td>
<td>HONEYWELL WEBS / SIEMENS / GREY STONE</td>
</tr>
<tr>
<td>3</td>
<td>Outside Air Temperature Sensor</td>
<td>HONEYWELL WEBS / SIEMENS / KELE</td>
</tr>
<tr>
<td>4</td>
<td>Water Flow Meter</td>
<td>HONEYWELL WEBS / SIEMENS / GREY STONE</td>
</tr>
<tr>
<td>5</td>
<td>Water Flow Switch</td>
<td>HONEYWELL WEBS / SIEMENS / CARRIER ALC</td>
</tr>
<tr>
<td>6</td>
<td>Thermostat / Humidistat</td>
<td>HONEYWELL WEBS / SIEMENS / JOHNSON</td>
</tr>
<tr>
<td>7</td>
<td>Water Flow Switch, Airstat</td>
<td>RAPID CONTROL / ANERGY</td>
</tr>
<tr>
<td>8</td>
<td>Vibration Isolator</td>
<td>RESISTOFLEX / EMERALD</td>
</tr>
<tr>
<td>9</td>
<td>Voltage / Current Transducer</td>
<td>ENERCON / CONZERV / ELECTREX / SETO</td>
</tr>
<tr>
<td>10</td>
<td>Frequency Transducer</td>
<td>ENERCON / CONZERV / ELECTREX / SETO</td>
</tr>
<tr>
<td>11</td>
<td>Personal Computer</td>
<td>HP / COMPAQ / IBM</td>
</tr>
<tr>
<td>12</td>
<td>Printer</td>
<td>EPSON / HP</td>
</tr>
</tbody>
</table>

**SOUND REINFORCEMENT SYSTEM**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Models/Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Speaker and Accessories</td>
<td>JBL/ Martin Audio/ EV/ K-Array</td>
</tr>
<tr>
<td>2</td>
<td>Amplifier</td>
<td>Crown/ EV/ Martin Audio/ Lapgruppen</td>
</tr>
<tr>
<td>3</td>
<td>Mixer,</td>
<td>Soundcraft / Yamaha / EV Midas</td>
</tr>
<tr>
<td>4</td>
<td>Processor, Graphic EQ &amp; Feedback Suppressor</td>
<td>DBX/ Biamp/ EV/BSS/Bose</td>
</tr>
<tr>
<td>5</td>
<td>Microphone and Accessories</td>
<td>AKG/ Shure/ Beyerdynamics/ Senheisser</td>
</tr>
<tr>
<td>6</td>
<td>Accessories and Hardware</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Wiring System:</td>
<td>Klotz or Equivalent</td>
</tr>
</tbody>
</table>

**VIDEO PROJECTION SYSTEM**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Models/Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Projector</td>
<td>Barco/ Christie/ NEC</td>
</tr>
<tr>
<td>2</td>
<td>Projection Lens</td>
<td>Schneider/ OEM</td>
</tr>
<tr>
<td>3</td>
<td>Motorised screen</td>
<td>DRAPER Or Equivalent</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Brands</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>4</td>
<td>LCD monitors with seamless border.</td>
<td>Sony/ Panasonic/ Samsung</td>
</tr>
<tr>
<td>5</td>
<td>Controller for video wall</td>
<td>Sony/ Panasonic/ Samsung</td>
</tr>
<tr>
<td>6</td>
<td>Video-Data Switcher cum scaler</td>
<td>Kramer / Extron</td>
</tr>
<tr>
<td>7</td>
<td>Touch Control System with Wired Touch Control Panel of 15”, Emitter Probes (as per requirement), Button Designer Pad (1no.) complete with all accessories.</td>
<td>CRESTRON/AMX</td>
</tr>
<tr>
<td>8</td>
<td>Video Conferencing System with ISDN/IP Compatibility, Including 4 PTZ cameras (Canon/ Sony)</td>
<td>SONY/ Polycom</td>
</tr>
<tr>
<td>9</td>
<td>DVD Recorder</td>
<td>SONY/ SAMSUNG</td>
</tr>
<tr>
<td>3</td>
<td>Stage Furnishing</td>
<td>PLS / AKE / SGM / CLAYPAKY SHARPR / PR</td>
</tr>
<tr>
<td>4</td>
<td>STAGE LIGHTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pabble Convex Spotlight /PAR Sealed Beam Light / Fresnel Spotlight / flood light</td>
<td>LDR/ Selecon/ ETC</td>
</tr>
<tr>
<td></td>
<td>Moving head spotlight</td>
<td>DTS / SGM / Clay Paky</td>
</tr>
<tr>
<td></td>
<td>LED</td>
<td>DTS/ SGM/ Studio Due</td>
</tr>
<tr>
<td></td>
<td>FULL COLOUR TRIPLE BRACKET</td>
<td>DTS/ SGM/ Studio Due</td>
</tr>
<tr>
<td></td>
<td>Make: DTS/ SGM/ Studio Due</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 Channel Splitter</td>
<td>Modern Stage Service/ Canara / Effectron</td>
</tr>
<tr>
<td></td>
<td>Electronic Dimmer</td>
<td>Modern Stage Service/ Canara / Effectron</td>
</tr>
<tr>
<td></td>
<td>Control panel</td>
<td>Avolite /SGM</td>
</tr>
<tr>
<td>5</td>
<td>Conference Delegate System</td>
<td>Bosch,Televic , or Equivalent</td>
</tr>
</tbody>
</table>

**Note :-** Contractors have to take approval from Engineer in charge / Consultants before placing of order of any required materials from the above mentioned approved makes. If any required materials (as per BOQ / Extra items) not available in above list Engineer in charge /Consultants can add the make / Brand in 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.