INSPECTION

(CHAPTER-05)
GENERAL SPECIFICATION
FOR
QUALITY SYSTEM, INSPECTION &
TEST OF PLANT / EQUIPMENT AT
MANUFACTURER’S PREMISES
(GS – 05)

MECON LIMITED
RANCHI – 834002

JULY, 2007
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### ENCLOSURES:

i) Form No. 11.20.(DQM)F-09 Rev-0 - QAP for Structural & Mechanical Equipment
ii) Form No. 11.20.(DQM)F-10 Rev-0 - QAP for Electrical Equipment
iii) Form No. 11.20.(DQM)F-11 Rev-0 - QAP for Refractory Materials
iv) Form No. 11.20.(DQM)F-5/2 Rev-0 - Inspection Call Proforma
v) LIST OF MECON OFFICES and Contact Address Details
GENERAL SPECIFICATION ON QUALITY SYSTEM, INSPECTION & TEST OF PLANT & EQUIPMENT AT MANUFACTURER'S PREMISES

1.0 GENERAL

1.1 Inspection & testing of plant & equipment shall be carried out by Consultant/ Purchaser at the works of successful tenderer during manufacturing and/or on final product to ensure conformity of the same with the acceptable criteria of technical specifications, approved drawings, manufacturing drawings and applicable national / international standards.

2.0 QUALITY SYSTEM REQUIREMENTS

The successful tenderer must recognise the importance of quality and follow defined quality programme in all stages of manufacturing and quality control activities of the product. Contractor must define and implement the tasks and controls that will provide needed assurance, in case manufacturing of product is sub-contracted either partly or fully and/or for the procured components of the product. All bought-out equipment or component shall be procured from vendors which are duly approved by the project authority.

Consultant/ Purchaser reserve the right to verify the quality programme of tenderer & its vendors/sub- vendors to assure the effectiveness of the programme to meet the intended and specified quality of the product.

3.0 QUALITY ASSURANCE PLAN (QAP)

3.1 The successful tenderer shall furnish Quality Assurance Plan (QAP) for respective equipment after completion of detailed engineering and finalisation of billing schedule / equipment identification number for Consultant's approval at least one month prior to start of manufacturing.

3.2 QAP shall be prepared & furnished by Contractor in Form Nos. 11.20(DQM) F-09,10, 11 (specimen copy enclosed) / detailed manufacturing QAP for structural & mechanical equipment, electrical equipment and refractory materials respectively, QAPs must be submitted in four (4) sets duly signed and stamped by tenderer for MECON approval.

3.3 The successful tenderer shall indicate procurement source and furnish to Consultant, during the submission of QAP, copies of P.O., Sub-P.O., T.S., approved GA drawings/ data sheets & detailed manufacturing drawings, as backup reference materials for scrutiny & final approval by Consultant. The submission & subsequent approval of QAPs shall be ensured to be restricted to one round only.

3.4 Inspection and test requirements shall be decided with due consideration of factors like safety, duty cycle, operating conditions, equipment life, environmental conditions, place of installation and statutory regulations, as applicable, for a particular equipment. Any, additional type or special tests or routine tests if found necessary to establish the intended quality after detailed engineering then the same shall have to be incorporated in the QAP without any commercial implication.

3.5 Detailed QAP shall be prepared by the successful tenderer in consultation with their Sub-contractors / Manufacturers to avoid any complicacy later.
4.0 **CALIBRATION OF MEASURING EQUIPMENT**

4.1 All the measuring equipment used for inspection & testing shall be calibrated and appropriate accuracy class of measuring equipment shall be used. Calibration standards used for calibration of measuring equipment shall be traceable to national standards of National Physical Laboratory (NPL), New Delhi with unbroken chains of comparison.

4.2 Valid calibration certificate for all measuring equipment used during inspection and testing at manufacturer's works, with traceability to national standards of NPL/ NABL accredited laboratories shall be furnished prior to undertaking inspection by Consultant/ Purchaser.

Calibration certificate shall also indicate reference no. of calibration standards calibrated by NPL/NABL accredited laboratories and copies of such calibration certificates of calibration standards shall be included in the compiled dossiers of inspection/test results.

5.0 **TEST CERTIFICATES AND DOCUMENTS**

5.1 For each of the items being manufactured as per approved QAP, following test certificates and documents, as applicable for each of the equipment, in requisite copies including original, duly endorsed by the Manufacturer/successful tenderer with appropriate linkage to project, purchase order and acceptance criteria etc shall be submitted to Consultant/ Purchaser.


ii) WPS, PQR & WPQ documents as per applicable code.

iii) Details of stagewise inspection & rectification records for fabricated items, castings, forgings and machined articles.

iv) Control dimension chart with records of alignment, squareness etc.

v) Manufacturer's material and performance/relevant test certificates for all bought-out items.

vi) Details of heat-treatment and stress relieving charts as per specification.

vii) Non-Destructive Test reports as per respective code.

viii) Static/dynamic balancing certificate for rotating components/machines.

ix) Hardness test certificate.

x) Pressure/Leakage Test Certificates.

xi) Performance Test Certificates for all characteristics.

xii) Routine / type / calibration /acceptance / special test (Type Tests etc) certificates for electrical items.
xi)  Surface preparation and painting certificates.

xiv)  Certificates from competent authority for the items coming under statutory regulations.

5.2 Where physical and chemical test certificates of material are not available, the successful tenderer/Sub-contractor shall arrange to have specimens and test samples of the materials, tested in his own laboratory at his cost and submit the copies of test results in requisite numbers to Consultant/Purchaser for review. Number of test samples against each heat/cast/lot or batch of materials, as applicable shall be as per relevant Indian or International Standards.

5.3 Where facilities for testing do not exist in the successful tenderer/Sub-contractor's laboratories or in case of any dispute, samples and test pieces shall be drawn by the successful tenderer/Sub-contractor in presence of Consultant/ Purchaser and sealed sample shall be sent to any Govt. approved /NABL accredited laboratory for necessary tests at former’s own cost.

5.4 The Consultant/ Purchaser shall have the right to be present and witness all tests being carried out by the successful tenderer/Sub-contractor at their own laboratory or approved laboratories. Also, the Inspection Agency shall reserve the right to call for confirmatory test on samples, at his discretion.

6.0 INTERNAL INSPECTION BY SUCCESSFUL TENDERER/MANUFACTURER

6.1 Inspection and tests shall be carried out by Contractor/ Manufacturer in accordance with approved drawings, T.S., P.O., and approved QAP. They shall maintain records of each inspection and test carried out and signed documents shall be submitted to Purchaser/Consultant for verification.

6.2 The successful tenderer shall carry out their internal inspection & obtain clearance from statutory bodies e.g. IBR, CCE, TAC, Weights & Measures, safety, IE rules etc. prior to offering any equipment for Purchaser/Consultant's inspection in accordance with approved QAP.

6.3 The successful tenderer/ Manufacturers shall identify all the inspected equipment/component/raw materials & shall maintain the record of status of inspection viz. inspected & found acceptable, require rectification/rework, rejected etc.

6.4 The successful tenderer shall establish and maintain procedures to ensure that the product that does not conform to specified requirements, is prevented from inadvertent use or installation. The description of non-conformity that has been accepted subsequently by Consultant/ Purchaser by concession and/or of repairs, shall be recorded.

Repaired and reworked product shall be offered for re- inspection to Consultant/ Purchaser alongwith records of corrective action taken.

7.0 MANUFACTURING AND INSPECTION SCHEDULE

All contractors shall submit the schedule for manufacturing and inspection indicating equipment / components, sub-assembly/ assembly. Date of approval of drawings / data sheets. Address of manufacturer with contact person and scheduled date of inspection. Such reports shall be submitted to respective Consultant Inspecting Offices with a copy
to Inspection Co-ordinating Office once in a month. These monthly reports shall state the planning for next three months. Submission of first reports must commence one month prior to commencement of manufacturing activities of the product.

8.0 METHOD OF UNDERTAKING INSPECTION & TESTING BY CONSULTANT/PURCHASER

8.1 Inspection call shall be given only on readiness of the equipment/assembly/sub-assembly & after approval of all relevant drawings and QAP. In case, equipment/assembly/sub-assembly offered for inspection are found not ready, all the cost of visit of Consultant's engineer shall have to be borne by the successful tenderer.

If the equipment/assembly/sub-assembly after inspection found not acceptable, require rework and involve Consultant's re-inspection, all the cost of such re-inspections shall also have to be borne by the successful tenderer.

8.2 Inspection call shall be floated to Consultant, in the enclosed Form No.11.20(DQM)F-05/2.REV-0 duly filled in, with ten days clear margin, enclosing all documents like test Certificates, Internal Inspection Reports, P.O., Sub-P.O., T.S., Approved QAP, approved GA drawings/data sheets and manufacturing drawings. Inspection calls without above documents shall be treated as invalid and shall be ignored. The hard copy of such documents must also accompany a CD (comprising computer readable files) containing the identical documents.

8.3 The successful tenderer shall offer substantial quantities for economical inspection consistent with the size of order.

8.4 On receipt of the Inspection call, pertaining to particular package/equipment/item, QA & Inspection group of Consultant, Ranchi (Overall co-ordinating office for Inspection activities) shall organize inspection visit or will issue Inspection assignment to other Consultant's office (based on nearness to the vendor's manufacturing works/relevant job expertise). For further inspection pertaining to the same package/equipment/item, successful tenderer may forward the subsequent inspection calls to the respective Consultant's offices (as identified per initial assignment), with a copy to QA & Inspection Section, Ranchi.

9.0 OBLIGATIONS OF SUCCESSFUL TENDERER

9.1 The successful tenderer shall provide all facilities and ensure full and free access of the Inspection Engineer of Purchaser/Consultant to their own or their Sub-Contractor's premises at any time, during contract period, to facilitate him to carry out inspection & testing of the product during or after manufacture of the same.

9.2 The successful tenderer shall delegate a Representative/Co-ordinator to deal with Consultant/Purchaser on all inspection matters. Representative of successful tenderer shall be present during all inspection at Sub-Contractor's works.

9.3 The successful tenderer shall comply with instructions of Consultant/Purchaser fully and with promptitude.

9.4 The successful tenderer/Sub-Contractor shall provide all instruments, tools, necessary testing & other inspection facilities to Consultant/Purchaser free of cost for carrying out inspection.

9.5 The cost of testing welds by ultrasonic, radiographic and dye penetration tests etc. in the fabrication workshop shall be borne by the successful tenderer. These tests need to be
witnessed by ASNT/ISNT Level-II qualified NDT personals

9.6 The successful tenderer shall ensure that the equipment/assembly/component of the plant and equipment required to be inspected, are not dismantled or dispatched before inspection.

9.7 The successful tenderer shall not offer equipment for inspection in painted condition unless otherwise agreed in writing by Consultant/Purchaser.

9.8 The successful tenderer shall ensure that the equipment and materials once rejected by the Consultant/Purchaser, are not re-used in the manufacture of the plant and equipment. Where parts rejected during inspection have been rectified as per agreed procedures laid down in advance, such parts shall be segregated for separate inspection and approval, before being used in the work.

10.0 STAMPING AND ISSUE OF INSPECTION DOCUMENTS

10.1 Inspection Memo:- For rejected items/items, which do not conform to Technical Specification in one or more quality characteristics requiring rectification/rework, Inspection Memo shall be issued indicating therein the details of observation & remarks. All the non-conformities with respect to specification of the product shall be indicated in the Inspection Memo for further quality control by successful tenderer.

10.2 Inspection Certificate:- On satisfactory completion of final inspection & testing, all accepted plant & equipment shall be stamped suitably and Inspection Certificate shall be issued by the Consultant for the accepted items.

11.0 GENERAL CLAUSE

11.1 Inspection & tests carried out by Consultant/Purchaser shall not absolve the responsibility of the successful tenderer/Manufacturer to provide acceptable product as per the terms of contract nor shall it preclude subsequent rejection.

11.2 Purchaser/Consultant reserve the right to inspect any product at any stage of manufacturing beyond pre-identified stages & hold points of approved QAP.
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<td>Package 2</td>
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</table>

**Notes:**
- All items shall be detailed in the equipment section.
- The installation shall be in accordance with the manufacturer's instructions.
- The equipment shall be tested and verified.
- Any modifications or deviations from the standard shall be noted.

**Instructor for Planning:**

**Date:**

**Contractor:**

**SU-CONTRACTOR:**

**FOR CONTRACTOR/SUB-CONTRACTOR:**

**FOR MECON:**

**Stamp & Sign (MECON):**

**Stamp & Sign (SU-CONTRACTOR):**
### QUALITY ASSURANCE PLAN

**FOR**

**STRUCTURAL & MECHANICAL EQUIPMENT**

**INSTRUCTIONS FOR FILLING UP:**
1. QAP shall be submitted for each of the equipment separately with break-up of assembly/sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.
4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

### CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS:

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<td>No. Load/Free Running Test</td>
<td>39</td>
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<td>Load/Overload Test</td>
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<td>8</td>
<td>Radiography test</td>
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<td>Measurement of speeds</td>
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### DOCUMENTS:

- D1: Approved GA drawings
- D2: Information and other reference
- D3: Relevant catalogues
- D4: Bill of Material/item no./identification
- D5: Matchmark details
- D6: Line/Layout diagram
- D7: Approved erection procedures
- D8: Unpriced sub-P.O. with specification and amendments
- D9: Calibration Certificate of all measuring instruments and gauges
- D10: Ordering Specification

### ABBREVIATIONS USED:

- CONTR: CONTRACTOR
- MFG: MANUFACTURER
- MFR: MANUFACTURER
- MECON: MANUFACTURER

### EQUIPMENT DETAILS

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<th>Identification No.</th>
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<th>Manufacturer’s Name and Address</th>
<th>Expected Schedule of Final Inspn</th>
<th>Raw Material and Inprocess Raw Test Certificate</th>
<th>Test Certificate &amp; documents to be submitted to MECON</th>
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### INSPECTION AND TESTS

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<td>MECON</td>
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### REMARKS/OTHER INFORMATION

For CONTRACTOR/SUB-CONTRACTOR (Stamp & Signature)

For MECON (Stamp & Signature)
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<th>Description</th>
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For CONTRACTOR / SUB - CONTRACTOR

for MECON (Stamp & Signature)

(Q. A. P. NO. TO BE ALLOTTED BY MECON)

NO. / / M.

For MECON (Stamp & Signature)
CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS:

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<td>4.</td>
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<td>7.</td>
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<td>Dye Penetration Test</td>
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<td>Measurement of R Value :</td>
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<td>11.</td>
<td>High voltage test/Dielectric test.</td>
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<td>Routine test as per relevant IS/other standard.</td>
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<td>Test Certificates for bought components.</td>
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<td>Tank pressure Test.</td>
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<td>Overspeed Test.</td>
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DOCUMENTS:

- D1. Approved GA drawings
- D2. Approved single line / schematic diagram.
- D3. Catalogues / Approved data sheet
- D5. Unpriced P.O. copy.
- D6. Calibration Certificate of all measuring instrument and gauges.

EQUIPMENT DETAILS:

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</tbody>
</table>

For CONTRACTOR / SUB-CONTRACTOR

For MECON (Stamp & Signature)
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Test Certificates &amp; Acceptance Criteria</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E Q U I P M E N T D E T A I L S</td>
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<td>REMARKS/ SAMPLING PLAN</td>
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</table>

For CONTRACTOR / SUB - CONTRACTOR

for MECON (Stamp & Signature)

(Q . A . P . NO. TO BE ALLOTTED BY MECON)
### INSTRUCTIONS FOR FILLING UP:

1. QAP shall be submitted for each of the equipment separately with break up of assembly/sub-assembly/part/component or group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.
4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

### CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Visual</td>
<td>14</td>
<td>Impact Test</td>
<td>D1</td>
<td>Approval GA drawings</td>
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<tr>
<td>2</td>
<td>Dimensional</td>
<td>15</td>
<td>Partial Discharge Test</td>
<td>D2</td>
<td>Approved single line / schematic diagram.</td>
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<tr>
<td>3</td>
<td>Fitment &amp; Alignment</td>
<td>16</td>
<td>Head run test/Temp. rise Test</td>
<td>D3</td>
<td>Catalogues / Approved data sheet</td>
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<tr>
<td>4</td>
<td>Physcal Test(Sample)</td>
<td>17</td>
<td>Enclosure protection Test</td>
<td>D4</td>
<td>Approval bill of materials</td>
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<tr>
<td>5</td>
<td>Chemical Test (Sample)</td>
<td>18</td>
<td>Calibration</td>
<td>D5</td>
<td>Unpriced P.O. copy</td>
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<tr>
<td>6</td>
<td>Ultrasonic Test</td>
<td>19</td>
<td>Noise &amp; Vibration</td>
<td>D6</td>
<td>Calibration Certificate of all measuring instrument and gauges</td>
</tr>
<tr>
<td>7</td>
<td>Magnetic Particle Test(MPT)</td>
<td>20</td>
<td>Test Certificates for bought out components.</td>
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<tr>
<td>8</td>
<td>Radiography test</td>
<td>21</td>
<td>Tank pressure Test</td>
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<td>9</td>
<td>Dye Penetration Test</td>
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<td>23</td>
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<tr>
<td>11</td>
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<td>24</td>
<td>Operation &amp; functional check</td>
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<tr>
<td>12</td>
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<td>25</td>
<td>Overspeed Test</td>
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</tr>
<tr>
<td>13</td>
<td>Type tests as per relevant IS/ other standard.</td>
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<td>Flame proof Test</td>
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<tr>
<td>14</td>
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<td>Clearance and creepage distance</td>
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<td>15</td>
<td>Ultrasonic Test</td>
<td>28</td>
<td>Acceptance Tests as per relevant IS</td>
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</tbody>
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### ABBREVIATIONS USED:

- **CONTR**: CONTRACTOR
- **MFG**: MANUFACTURER
- **MECON**: MANUFACTURER

### FORM NO. 11.20 (DQM) F-10, REV-0

**QUALITY ASSURANCE PLAN**

**FOR**

**ELECTRICAL EQUIPMENT**

**INSPECTION AND TESTS**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No / M / T</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Improv. stage Inspection</th>
<th>Final Inspection / Test by Documents</th>
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<th>CONTR</th>
<th>MECON</th>
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<th>MECON</th>
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<tr>
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</tbody>
</table>

**Acceptance Criteria**

- Test Certificates & Documents to be submitted to MECON
- ASME/BSI/IS/other standard

**REMARKS**

- Raw Material and Improv. stage Inspection
- Final Inspection / Test by Documents
- Acceptance Criteria
- Test Certificates & Documents to be submitted to MECON
- ASME/BSI/IS/other standard

**SAMPLING PLAN**

For **CONTRACTOR / SUB-CONTRACTOR**

Signed **MECON** (Stamp & Signature)
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification No.</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule of Final Inspection</th>
<th>Raw Material and Inprocess Stage Inspection</th>
<th>Final Inspection / Test by</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria Standards/IS/BS/ASME/Norms and Documents</th>
<th>REMARKS/SAMPLING PLAN</th>
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</table>

For CONTRACTOR / SUB-CONTRACTOR

for MECON (Stamp & Signature)
**QUALITY ASSURANCE PLAN**

**FOR**

**REFRACTORY MATERIALS**

**INSTRUCTIONS FOR FILLING UP:**

1. **QAP** shall be submitted for each of the equipment separately with break up of assembly/sub-assembly/part/component or for group of equipment having same specification.

2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment.

3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specification belonging to different facilities are grouped together.

4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

**CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS:**

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<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
<th>DOCUMENTS</th>
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<tbody>
<tr>
<td>1</td>
<td>Visual</td>
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<td>Drying &amp; firing shrinkage</td>
<td>D1. Laboratory test report</td>
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<tr>
<td>2</td>
<td>Dimensions and geometry</td>
<td>19</td>
<td>Sieve analysis</td>
<td>D2. Dimensional drgs. showing</td>
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<tr>
<td>3</td>
<td>Chemical composition</td>
<td>20</td>
<td>Warpage</td>
<td>D3. Copies of sub P.O. &amp;</td>
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<td>21</td>
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<td>Technical Specification.</td>
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<td>Hydration resistance test</td>
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<td>Abrasion resistance</td>
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<td>Cold bonding strength</td>
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<td>10</td>
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<td>Oxidation resistance</td>
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<td>Resistance to dis-integration effect</td>
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<td>Flexural strength</td>
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<td>Water absorption</td>
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<td>Internal Inspection Report</td>
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<td>Acid resistance</td>
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<td>Safe working temp.</td>
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<td>Thermal conductivity</td>
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<td>18</td>
<td>Drying &amp; firing shrinkage</td>
<td>35</td>
<td>Part assembly</td>
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<td>19</td>
<td>Sieve analysis</td>
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**ABBREVIATIONS USED:**

- **CONTR**: CONTRACTOR
- **MFR**: MANUFACTURER

**EQUIPMENT DETAILS**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Description (with equipment heading, place of use and brief specification)</th>
<th>Identification</th>
<th>Quantity</th>
<th>Manufacturer's Name and Address</th>
<th>Expected Schedule (date) of Final Inspection</th>
<th>Raw Material and Inprocess stage Inspection</th>
<th>Final Inspection/Test by</th>
<th>Test Certificates &amp; documents to be submitted to MELCON</th>
<th>Acceptance Criteria</th>
<th>REMARKS/SAMPLING PLAN</th>
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**INSPCTION AND TESTS**

- **MFR**: MANUFACTURER
- **CONTR**: CONTRACTOR
- **MECON**: MELCON

**(Q. A. P. NO. TO BE ALLOTTED BY MECON)**

**REVIEWED**

**FOR CONTRACTOR / SUB-CONTRACTOR**

(Stamp & Signature)

**FOR MELCON (Stamp & Signature)**

**SHEET 1 OF 2**
<table>
<thead>
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<th>Sl. No</th>
<th>Description (with equipment identification, including place of use and brief specification)</th>
<th>Manufacturer's Name and Address</th>
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<th>Raw Material and Inprocess Test Certificates</th>
<th>Final Inspection / Test by</th>
<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria</th>
<th>Remarks / SAMPLING PLAN</th>
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<tr>
<td></td>
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<td></td>
<td>Standards/IS/BS/</td>
<td>Sample Plan</td>
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<th>Test Certificates &amp; documents to be submitted to MECON</th>
<th>Acceptance Criteria</th>
<th>Remarks / SAMPLING PLAN</th>
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<tbody>
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<td>Standards/IS/BS/</td>
<td>Sample Plan</td>
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<td>ASME/Norms and</td>
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<td></td>
<td>Documents</td>
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**Equipment Details**

**Inspection and Tests**

---

**For CONTRACTOR / SUB-CONTRACTOR**

For MECON (Stamp & Signature)
<table>
<thead>
<tr>
<th>Inspection Call No.</th>
<th>Date</th>
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<tbody>
<tr>
<td>Project</td>
<td>Purchaser</td>
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<tr>
<td>Contractor</td>
<td>Contractor's Order No. &amp; Date</td>
</tr>
<tr>
<td>Sub-Contractor</td>
<td>Place of Inspection with address, Fax &amp; Ph. No.</td>
</tr>
<tr>
<td>Proposed Date of Inspection</td>
<td>Name &amp; Designation of Contact Person with Ph. No.</td>
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<tr>
<td>Manufacturer’s Off-day</td>
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**List of items offered for inspection:**

<table>
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<tr>
<th>Item Identification No.</th>
<th>Item Description</th>
<th>Drawing No. with Revision</th>
<th>Drawing Approval Status A/AAN/INF</th>
<th>QAP No. &amp; Status</th>
<th>Quantity (No./M) with tonnage</th>
<th>Total Ordered</th>
<th>Total Accepted</th>
<th>Offered</th>
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</table>

A = Approved, AAN = Approved as Noted, INF = Information Category

**List of documents & Test Certificates enclosed in four (4) sets.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Ref No. &amp; Date</th>
<th>Description</th>
<th>Ref No. &amp; Date</th>
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for Contractor/Sub-Contractor
<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DETAILED ADDRESS</th>
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<td>D.G.M. Inspection Section</td>
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<td></td>
<td>MECON Ltd., 89, South End Road, Basavanagudi, Bangalore-560 004 (Karnataka)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gram : MECONIND</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fax : 080-6576352</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phone : 080-6571661-68/6576476</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-mail : <a href="mailto:bangalore@mecon.co.in">bangalore@mecon.co.in</a></td>
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<tr>
<td>2.</td>
<td><strong>BHILAI</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dy. General Manager</td>
<td>Bhilai, Nagpur, Raipur, Bilaspur, Bhopal, Satna &amp; Katni</td>
</tr>
<tr>
<td></td>
<td>MECON Ltd., Ispat Bhawan, 1st floor, Bhilai-490 001 (M.P.)</td>
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<tr>
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<td>Gram : MECON</td>
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<tr>
<td></td>
<td>Fax : 0788-224452</td>
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<td>Phone : 0788-220107/224101/224454</td>
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<td>Chennai- 600 102</td>
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<td>Phone : 044-26261911,26269743</td>
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<td>E-mail : <a href="mailto:chennai@mecon.co.in">chennai@mecon.co.in</a></td>
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</tr>
<tr>
<td></td>
<td>Fax : 033-22824441</td>
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</tr>
<tr>
<td></td>
<td>Phone : 033-22822381 to 83,22822284,22822857</td>
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<td>7.</td>
<td><strong>NEW DELHI</strong></td>
<td>Delhi, Punjab, Rajasthan</td>
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CONVEYOR SYSTEM & RELATED EQUIPMENT

01.00 Scope

1. The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, transit insurance, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories the following components for all the conveyors indicated in the enclosed drawings.

   i) Motors 
   ii) Gear boxes 
   iii) Couplings 
   iv) Pulleys with bearing blocks – head, trail, snub bend and take-up 
   v) Idlers – carrying, return, impact, self-aligning and transition 
   vi) Idler frames 
   vii) Belt cleaning devices 
   viii) Hold back devices 
   ix) Electro-magnetic brakes 
   x) Pull-cord switches with cord 
   xi) Belt sway switches 
   xii) Zero-speed switches 
   xiii) Take up pulley frame with take up guides 
   xiv) Bend pulley frame 
   xv) Head pulley frame 
   xvi) Tail pulley frame 
   xvii) Drive base frame 
   xviii) Guards – tail pulley, bend pulley, coupling 
   xix) Discharge hood up to 500 mm below the discharge pulley platform 
   xx) Skirt Boards 
   xxi) Belt Weigh Scale – wherever required

2. The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

3. The scope of supply and services of the Tenderer shall include the following:

   a) Mechanical
      - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, structural, mechanical and other standard accessories.
      - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment.

   b) Electrical
      - LT AC motors and brakes with rectifier panels as required for the equipment.
      - Switches as necessary for interlocking and control and safe operation of equipment.
      - Complete flexible cable festoon arrangement with protective chain, cable guide & rollers, junction boxes etc. required for shuttle conveyors / carriages including power & control flexible cables and their termination up to junction boxes. Junction boxes for power and control supply shall be separate and shall be supplied by the Tenderer.
Any other mounted electrics that may be required for satisfactory operation and maintenance of equipment supplied by Tenderer.

01.01 Design Basis & Hierarchy of Specifications

The equipment shall be designed as per design criteria given below:

Hierarchy of Specifications
a) Technical Specification
b) General Technical Specification (GTS)
c) Inter Plant Standard for Steel Industries (IPSS)
d) Indian Standard (IS).
e) Indian Electricity Rules & statutory requirements of Central Govt. and State Govt.

Equipment complying with other recognised Standards such as IEC, BS, VDE, and IEEE will also be considered if it ensures performance equivalent to or superior to Indian Standards.

The components and materials used and the equipment supplied shall conform to high standards of design, engineering and workmanship and shall be suitable for efficient operation and reliable service in steel plant conditions.

Design Basis

- Utilisation of cross sectional area - 80% of theoretical cross sectional area indicated in IS 11592-2000 (for computation of belt speed)
- Design capacity of belt conveyors - 20% more than rated capacity to be considered while calculating motor power
- Troughing angle - 35°
- Friction factor (for kW calculation) of belt conveyors - 0.03
- Idlers - 152.4 mm Outer Diameter with 5.0 mm shell thickness
- Flat return Idlers – 152.4 mm Outer Diameter.
- Carrying idler spacing - 1000 mm. Spacing in the convex curve position of conveyor shall be limited to half the normal spacing of carrying idlers
- Return idler spacing - 3000 mm spacing
- Training Idler spacing
  a) Carrying side - 15 m
  b) Return side - 30 m
Impact idler spacing - 500 mm or less - (min. 6 Nos.)

Deck plate - 3.15 mm thick wherever specified

Drive pulley – 12 mm thk. vulcanized natural rubber lagging, minimum durometer hardness of 55o shore A scale. Pulley shell thickness 16 mm minimum

Tail/ Bend/take-up pulley – 10 mm thk vulcanized natural rubber lagging, minimum durometer hardness of 45o shore A scale, and shell thickness 12 mm minimum.

Pulley face width - As per IS 8531-1986, Reaffirmed in 1993.


Pillow blocks
   a) Material - cast iron / cast steel
   b) Bearing - Self aligning spherical roller bearing
   c) Life - 40,000 working hrs min
   d) Construction - Horizontal split type (one end fixed and the other end expn. type)

Reducer
   a) Service rating of 1.5 times the calculated shaft kW and thermal capacity of gear box shall be better or equal to that of motor

   b) Material - fabricated or cast steel

   c) kW rating shall be not less than 1.25 times the motor kW. Higher value of ‘a’ or ‘c’ will be considered

   d) No worm gear except for traveling gate

Brakes

D.C. electromagnetic brakes on conveyors wherever required
   - To prevent roll back
   - Where stopping time regulation is required.

Roller type hold back device - To be provided on all inclined conveyors to prevent roll back.
Rating minimum 1.5 times the maximum calculated torque.

Take up
   Screw take up - up to 40 m (with protected thread)
   Automatic take up travels as per I.S.

High speed coupling - gear coupling/ resilient coupling less than 30 kW

Fluid coupling for 30 kW & more
   (Pin bush coupling - Not Applicable)

Low speed coupling - gear or resilient.
01.02 Belt Conveyor system

1. General

All equipment shall be designed, manufactured, supplied, erected, tested and commissioned in accordance with relevant Indian Standards, IPSS and International Standard where applicable in addition to the requirement mentioned herein.

The Supplier shall make his own calculation in respect of belt speed, motor kilowatt, belt tension etc. of belt conveyors to ensure satisfactory performance of the conveyor components and system as a whole. The drive motor selected shall not be of lesser kW than what is indicated and the belting chosen shall not be of inferior quality than what is specified. The starting torque of drive motor and the high speed coupling shall be so chosen as to allow soft start condition.

Adequate no. of locating pins and match marking shall be provided for easy assembly and dismantling.

Standardisation of components and assemblies shall be carried out to the maximum possible extent to ensure interchangeability.
All equipment shall be designed such that all components are easily accessible for inspection, repair and maintenance.

2. Conveyor Belting

Beltling shall be designed for heavy duty condition and shall be suitable for 24 effective working hours operations per day and 365 working days per year. It shall be suitable for installation over conveyor system having 35° troughing angle and shall be suitable for operation at an ambient temperature of 50°C. It shall have sufficient resistant against exposure to open sunlight so that its qualities do not deteriorate while working in open sun. It also may have to work in rain and / or in conditions where relative humidity goes upto 100%.
The fabric for belting shall be of Nylon/Nylon heavy duty type. The belting shall be pre-stretched, straight ply, skin coated with open ends. It shall have sufficient strength to give required tension at 10 safety factor and 80% tension utilistion. All belts shall be joined by vulcanized splicing.
The belt shall have sufficient lateral flexibility so that it suits the troughing angle requirements even when it is empty. The belt shall have sufficient longitudinal flexibility so that it can easily flex around different pulleys of the conveyor system. The belt shall have sufficient impact resistance to withstand impact at the loading points. The rubber cover used in the top and bottom cover of the belting generally shall be of M-24 grade. For material above 50 deg C cover shall be of HR grade and material above 100 deg C & red hot FR grade belt shall be provided. The edge shall be of cut edge construction.

On the carrying surface, at interval of maximum 12 meters, the belting shall be marked as follows:

a) Manufacturer’s name and trade mark, if any.
b) Fabric designation as NN
c) Belt designation i.e. KN/m
d) Code of rubber cover i.e. M-24.
e) Last two digits of year of manufacturing.

Belt roll shall be packed in wooden drums. This packing should enable easy unreeling of the belting. On the body of the wooden drum the direction of belt and location of end of the belting should be indicated so that belting can be properly placed while unreeling.

The design, construction, testing and performance of the belting shall comply with all applicable codes and as per IS, IPSS and International Standards.

Before dispatch, the finished material shall be subject to inspection by the Purchaser/MECON. The inspection shall be carried out in the presence of Purchaser/MECON, in terms of up to date engineering practice and relevant IPSS, IS and International Standards in this respect, for which all facilities shall be provided by the Contractor at his cost. This shall interalia, include the following:

a) Full thickness belt test
   i) Breaking load, Kg/sq. cm for wrap and weft.
   ii) Elongation under reference load (%).
   iii) Elongation at break (%).

b) Rubber cover test (Top/Bottom)
   i) Tensile strength of cover, Kg/sq. cm
   ii) Elongation at break (%)
   iii) Adhesion between ply to ply and between covers and ply.
   iv) Abrasion loss of rubber cover

c) Physical dimension check

d) Flexibility Test

All relevant type test certificates shall have to be produced during inspection and along with supply for necessary verification and approval.

3. Conveyor Pulleys
All pulleys shall be of welded steel construction, stress relieved before boring and machining and statically balanced. Solid end discs shall be designed and provided to give maximum strength. Pulleys shall be designed as per relevant Indian Standard and IPSS where applicable. Pulleys shall be connected to the shaft preferably through keyless friction grip connections for HT motors and key connection for LT motors unless otherwise agreed.

Shell thickness of the pulley shall be suitable for taking bending loads on the pulley. This shall not be less than 16mm for drive pulley and 12 mm for tail and other pulleys.

Drive pulleys shall be covered with minimum 12mm thick diamond rubber lagging. Tail, bend and take-up pulleys shall be covered with minimum 10 mm thick diamond rubber lagging. The depth and width of the grooves in the lagging shall be 6 mm spaced at 30mm interval. The eccentricity of pulley shell shall not be more than + 0.5% of the diameter prior to lagging. Drive pulleys shall be machined at steel faces prior to lagging. Shore hardness of rubber for drive pulleys shall be not less than 55 deg A and for other pulleys shall be not less than 45 deg A. All pulleys shall be statically balanced to minimize the vibration during running.

Rolled steel may be used for pulley shafts of diameter up to 140 mm. Forged steel shall be used for shafts above 140 mm diameter. The deflection slope of pulley shaft at bearings shall be restricted to 1/2000 under rated load condition. Combined stress value shall be restricted to 500kg/sq.cm. Shaft diameter shall be selected based on the maximum value. The shaft diameter shall be as per IPSS.

Pulley shafts shall be supported on self-aligning double row spherical roller bearings with adequate sealing and external lubrication arrangement in plummer blocks. One bearing for each shaft shall be fixed to prevent any movement of the shaft assembly and the other bearing shall be floating to have free axial movement. All lubricating nipples shall be readily accessible without removing the guards. All plummer blocks shall also have four mounting bolts.

Welding on the pulley shell shall be tested radio graphically or by ultrasonic method. Pulley shafts shall be ultrasonically tested. Checking of out of roundness and static balancing tests shall be carried out before dispatch of the pulleys.

### 4. Idlers

Three roll inline troughing idlers of equal length shall be used throughout. The angle of inclination of side rollers to horizontal shall be 35°. Troughing as well as return idlers shall be of reputed make and manufactured out of heavy duty seamless tube/ERW tubes as per IS:9296-1983. Spindle - Class 4, IS :1875-1992. Frame - Rolled section. Troughing Idlers - in line equal rolls. Idlers shall be of “drop-in-slot” type. Minimum diameter of idlers shall be as follows:

Carrying Idlers – 114.3 mm Outer Diameter for 500 mm and 650 mm belt and 139.7 mm for higher width belt with 4.5 mm shell thickness. Transition idler at 10° and 20° troughing at both head and tail end.

The eccentricity (diametrical run out) of troughing and return idlers shall not exceed + 0.8 mm. Minimum shell thickness of idler tube shall be 5.0 mm. All idlers shall be fitted with either heavy duty deep groove ball bearings or seize resistant ball bearings. The bearings shall be held positively on the shafts. Multi-labyrinth seals shall be used for retention of grease. All bearings shall be greased and sealed for life against ingress of dust, water and escape of grease. All bearings shall be rated for minimum 40,000 working hours. Bearing - Taper roller bearing/ deep groove. Bearing housing of idler shall be made of pressed steel of CRCA sheet press fitted and preferably be welded with idler tube.
Self-aligning troughing and return idlers with vertical guide rollers shall be of above specified construction. All self-aligning idlers shall be provided with grease lubricated anti-friction bearings at pivot points. All grease fittings shall be of the button head type or equivalent and shall be accessible from the walkway side of the conveyor by piping. The grease tubing shall be made of aluminium. The grease fittings shall have adequate protection against dust collection.

Impact cushioned idlers shall be of above specified construction. The rings or disc for impact idler shall be made of rubber. The minimum number of impact idlers at each loading point shall be six. The first impact idler shall be placed approx. 150 mm behind the loading point. Conveyor with multiple loading points shall also be provided with impact idlers at each loading points.

Transition idlers of above specified construction shall be used adjacent to head and tail drums to permit proper support of loaded belt near the head and tail pulleys without excessive stress and stretch of the belt edges. The transition idlers shall be installed in steps of 10o, 20o toughing angles. Horizontal carrying idlers for supporting flat loaded belts shall also be of above specified construction. Return idlers for wet or sticky material shall be of rubber disc type of two roller trough design. Flat return idlers only shall be used under the "V" scrapers and in high tension areas. One number disc type self cleaning idler shall be provided near discharge pulley.

Training idlers shall not be used close to belt-weighing scales.

Idler shaft shall be made of class -4, IS-1875 or EN-8, BS-970 or bright bar of equivalent grade suitable for the duty requirement. Idler frame shall be made of rolled/ formed steel with provision for securely bolting to the stringers of the conveyor frame. All fixing bolts shall have spring washers.

Clearance, gap etc. for the carrying and return idlers shall conform to the relevant IS/IPSS Standard to extent possible. The fixing arrangement of carrying and return idlers shall be such as to permit adjustment of idler sets for the purpose of belt training. Allowance for such adjustment shall be provided on both sides of the conveyor and the play shall not be less than 10 mm on either side.

All idler rollers shall be painted with 2 coats of red oxide primer and 2 coats of enamel finish paint.

Following tests shall be carried at random on the assembled idler roller in the presence of Purchaser / MECON:

a) Friction factor test
b) Idler running test at high speed.
c) Test for dust proof
d) Test for water proof
e) Quality test.
f) Alignment and co-axiality test.

5. **Belt Cleaners**

a) External belt cleaners

External belt cleaners shall be provided at the discharge pulley of the conveyors. The cleaner shall have sprung metallic blades (in segments) with tungsten carbide tips.
Polyurethene deflector skirts shall be provided below the tips to prevent materials build up on the unit. The cleaners shall be mounted on an elastomount system to facilitate automatic blade adjustment on wear. The inclination of the blades should be such as to effect efficient scrapping of the belt. The spring action of the individual metallic blades should ensure constant contact with belt during operation and suitable sprung deflection of contact with uneven surface of the belt. The blades shall be in segments for ease of replacement and mounting on the head pulley frame. The material scrapped should fall inside the discharge chute directly.

b) Internal scraper

‘V’ shaped internal scraper shall be provided on the upper side of the return belt near the tail end, fitted with wear resistant non-metallic scraper blade to remove spilled materials on the belt. The blade shall be adjustable after the wear.

6. Gear Boxes

Conveyors shall be driven through totally enclosed oil-cooled reduction gearing having anti-friction bearings with oil seals at shaft projection. These shall be suitable for continuous operation at full load and shall be suitable for shock loads. Wherever required, oil temperature rise over ambient shall be restricted by 50°C (Max.). Worm gear or chain drive shall not be used. The reducers shall be selected with a service rating of minimum 1.5 times of motor kW or 1.8 times the calculated kW whichever is higher. The transmission efficiency of the gear shall not be less than 0.98 per stage. The material of gears, profile and geometry shall ensure high power/weight ratio with low volume. Gears and pinions shall preferably be solid forged. Where forging is not possible, forged steel gear rims shall be fitted on steel centers to withstand shock loads. All reducers shall have permanent magnet plugs. All gear box shall be of fabricated steel or cast steel casing construction. No cast iron casings shall be used.

7. Couplings

Flexible couplings shall be used between motor and gear-box and geared couplings shall be used between gear-box and drive pulley. The hub and sleeves of the geared coupling shall be of forged C-40 steel and bolts shall be of alloy steel. The hub teeth shall be of triple vary crown design. Traction type fluid coupling shall be used between motor and gear-box for drives of 30 kW to 100 kW, Delayfil Chamber type fluid coupling for LT motor above 100kW and Scoop controlled fluid coupling (Air cooled type) for HT motor to be used. All coupling bolts shall be replaceable without shifting of drive components.

8. Hold Back and Brakes with panel

All inclined conveyors shall be provided with suitable roller type hold back devices (other than brakes) to prevent belt from running back in case of conveyor stoppage due to power failure or otherwise. Holdback rating shall be minimum 1.5 times the maximum calculated torque.

D.C. Electro-magnetic brake shall be provided on all conveyors after calculating the coasting time. Brake shall have min 1.5 times the max. calculated torque rating. Brakes shall be mounted on brake drum coupling at input shaft end of gear box. Rectifier panel complete with contactors, timer, fuses, rectifier, resistors etc. shall be provided with each brake.

9. Take Up
All conveyors up to 40 meter in length shall have screw take-ups having protected threads. Take-up travel shall be minimum 500mm. The screw of the screw take-up shall be of square thread type and stainless steel construction with brass nut.

Automatic counterweight gravity take up shall be provided for conveyors above 40 meters in length. Horizontal gravity take up/VGTU shall be provided wherever feasible. Take-up travel shall be as per IS:4774 (part-I) and it shall be complete with pulley carriage suitable for guide structure made of pipe. Suitable hoisting arrangement shall be provided to handle cwt. Weight/Gravity take up pulley .Metallic counter weight shall be used.

10. Discharge Hood

Hood shall be made of 6mm thick mild steel plate for portion above the pulley frame. For portion of hood below the pulley frame and upto 500 mm below the floor, the thickness of plate shall be 10mm. 10 mm thick liner plate shall be provided in this portion of hood in the material impact zone. The hood shall be in segments bolted to each other for ease of maintenance. The hood shall cover discharge opening for the chute as well as pulley. Rubber curtain and guard shall be provided at the entry of belt in the discharge hood. Easily adjustable baffle plates shall be provided in the hood to control trajectory of materials, if necessary.

Hinged inspection door shall also be provided in the hood. The door shall preferably be located within a height of 1200 mm from the floor. Adequate opening shall be provided in the hood for withdrawal and adjustment of belt scrapers.

11. Guards

Guards on the conveyor shall comply with the relevant IS/IPSS Standard. The guards shall be of expanded metal conforming to IS: 412 (current)

Safety guards shall be provided for all couplings, brakes etc. of the conveyor drive and screwed on the above base frame.

12. Chutes

All transfer points shall be provided with non choking chutes made of minimum 10 mm thick mild steel plates and shall be constructed in small segments for easy dismantling.

Hinged type sealed inspection doors shall be provided at suitable height and location. The size of the door shall allow replacement of liners without any dismantling.

Snub pulley near discharge end shall be covered with spillage chutes.

Chutes shall be designed such that impact of the material on the conveyor is minimum. They shall be designed to ensure continuous flow of material to the centre of the belt with minimum spillage, noise and dust emission.

Minimum valley angle of the chute shall be 55 deg. to the horizontal. Minimum angle of slope of chute plate shall be 60 deg. The valley angle and slope angle shall be suitably increased for handling wet or sticky material.

Adjustable stone box shall be provided at discharge end of chute for arresting the free fall of material and to form a natural bed of material for protecting the parent plate. Chutes shall be
oriented as far as possible so as to ensure discharge of material in the direction of travel of receiving belt.

Liner shall be as follows:

Bunkers- For lumps of more than 80 mm size, Reinforced Rubber liner of 40 mm thickness (minimum) in secondary impact zone, 60mm thick reinforced rubber liner in Primary impact zone & 10 mm thick SAIL hard/ LA60/warest in rest of the portion upto 1 m height. For storage bunkers of fine/ sized material (lump size less than 20mm) cast basalt or 6mm thick SS-410 /SS-316 may be used at inclined area. For lump size between 20mm to 80mm 40 thk rubber liner shall be used.

Chute- Rubber liner of 40 mm thickness (minimum in secondary impact zone and 60 mm in primary impact zone for lumps of 40mm and above of coal and ore. For coke lumps 40mm and less, 20 mm thick PU liner/ SS-409 M (8 mm thick) shall be used.

For ore lumps 40mm and less stainless steel liner (SS-304/SS-409)6m thick shall be used.

13. Conveyor Frames

Conveyor frames shall be made of joists and/or channels suitably stiffened and braced. The spacing of supports shall not exceed 3000 mm. Frames shall be connected to floor beams/civil foundation of junction house by bolting.

14. Deck Plates

Deck plates of minimum 3.15 mm thickness shall be provided throughout the length of shuttle conveyor to avoid spillage of materials from the carrying side of belt on to the return side. For other conveyors, loading zones (at least 15m), within /junction /houses and at road/rail crossings etc. shall have deck plates.

15. Skirt Boards

Skirt boards of minimum 5000 mm length shall be provided at the loading points of all conveyors, however wherever dust-suppression system with water spraying arrangement is provided – the length & height of the skirt shall be suitably designed. Wherever the loading points are nearer to each other, the skirt board shall be made continuous between them. Minimum length of skirt boards from the beginning of loading area in the chute shall be 2500 mm in the direction of belt travel. Skirt shall be totally covered where dust extraction system is envisaged or when handling dry fine materials (-10 mm). The thickness of skirt plate shall be minimum 10 mm. The top cover plate where provided shall be minimum 3 mm thick. Skirt plates shall be provided with suitable (minimum 10 mm thick) replaceable liners.

The arrangement for fixing rubber curtain and PU board (Min 15 thk) shall be used for side sealing so as to ensure quick adjustment. The thickness of rubber curtains shall be minimum 10 mm. PU block shall be in segments and the design shall ensure automatic adjustment of block for proper sealing. Shore hardness of skirt rubber shall be min. 55o A.

16. Drive Base Frame

The drive unit consisting of motor, gear-box, coupling and brakes along with protective guards shall have a common base frame and shall be fabricated form heavy structural sections and plates. Suitable bracings should be provided wherever necessary on the drive unit base frame and structure to make it rigid. Proper arrangements shall be provided with
gear-boxes and motors to maintain correct alignment with finish pads for mounting. The drive base frames shall be bolted to the structural floor beams/civil foundation of junction houses provided by the Purchaser. Necessary load data and foundation details shall be furnished by the successful Tenderer to facilitate design of the structural / civil floor for accommodating the fame by the Purchaser.

17. **Reversible Shuttle Conveyors**

Refer TS drawing showing the general arrangement of reversible shuttle conveyors. Shuttle conveyors shall have independent drive for travel motion through electric motor and bevel helical gearbox. Stringer frame for the conveyor shall be in segments independently supported on wheels and connected together through hinged pins. Screw take - up arrangements for the belt conveyors shall be positioned at one of the hinged joints to avoid shifting of discharge pulley location in the discharge hood.

Double flanged parallel tread wheels shall run on flat bottomed rails of minimum 60 lb/yd and shall have min hardness of 350 BHN. Cleaners shall be provided to sweep the rail from spilled material. Anti-friction bearings shall be used throughout. The travel drive shall be so designed that no part of equipment shall project below rail level.

The belt conveyor shall be driven through motor and bevel-helical gear box. All other stipulation for conveyor component as detailed above shall be applicable for the shuttle conveyor.

The minimum clear distance between two adjacent shuttle/ reversible shuttle conveyors shall be 1000mm at any given position of the same.

Power supply shall be given through flexible trailing cable system.

Position indicators shall be provided as per requirement of control logic.

18. **Belt Feeders**

Belt Feeder shall be rugged construction having heavy duty flat belt, life sealed idlers. Inlet opening to the feeder shall be equipped with a manually adjustable vertical slide gate to adjust the depth of material in the feeder. The load area shall be skirted on three sides. The width of belt shall be so chosen that material shall not rub with the side skirt. The feeder below hopper / bunker shall be driven with a variable speed drive and rest with normal drive. The speed of feeder below hopper / bunker shall be provided with facility to put on or withdrawal of endless vulcanized belts from side. Belt scraper shall be provided to clean carrying as well as return side of the belt.

19. **Pull Cord Switches**

Pull cord switches shall be provided for emergency stoppage of conveyor. The first switch shall be about 4000 mm away from the driving drum and subsequently at not more than 30 m interval. The pull wires shall run along the entire length of each conveyor on both sides. Where mobile trippers are used on conveyors, the pull wires shall run along the hand-railings on conveyor walkways. All pull cord switches shall have individual local indication lamps to indicate when operated.

20. **Belt Sway Switches**
Belt sway switches shall be provided on each conveyor for protection against excessive sway of the belt. A pair of switch shall be installed near the head end and a pair near the tail end and a pair of switch shall be installed at 100 m interval thereafter. A pair of these switches shall also be provided before the belt weighing scales.

21. Belt Slip Switches

Belt slip switches shall be provided for each conveyor to stop the drive in case of excessive slippage of belt or over speeding. Provision shall be made such that preceding conveyor does not start unless the running conveyor picks up 80% of the rated speed.

22. Chute Jamming Detectors

Chute jamming detectors shall be provided on each chute. The detectors shall be so located or protected that they do not come in contact with regular flow of material. The detector shall, also, be protected against deposit of fine particles causing false alarm or stoppage of the conveyors. The position of each detector shall be decided based on the braking time of the delivery conveyor at rated capacity and the holding capacity of the chute.

23. Motors

Totally enclosed fan cooled squirrel cage motors shall generally be used for all the above mentioned equipment unless it is necessary to use slip ring or D.C. motors for speed control. Where power requirement is more than 180 KW, HT motors shall be considered. All LT motors from 30 KW and above shall be suitable for continuous duty (S3) category and all motors below 30 KW shall be suitable for intermittent duty (S4) category.

01.03 Erection Norms

Erection of all equipment shall be carried out as per manufacturer's recommendation.

Manufacturer's standards and recommendations for tolerances in assembly and erection shall be submitted to the Purchaser before actual erection of equipment.

Unless specified otherwise by equipment manufacturers, equipment shall be installed within the tolerances indicated below:

<table>
<thead>
<tr>
<th></th>
<th>Supporting structures for drive pulleys, tensioning drum, intermediate frame, electric motor, gearbox &amp; idler supporting structure.</th>
<th>In height 3.0 mm In horizontal plane - 1/1000 of length in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Driving pulley</td>
<td>1/1000 of length of pulley in vertical plane.</td>
</tr>
<tr>
<td>b)</td>
<td>Axis of conveyor &amp; center line of drum.</td>
<td>10 mm in horizontal plane.</td>
</tr>
<tr>
<td>c)</td>
<td>Tension pulley</td>
<td>± 2 mm in vertical plane</td>
</tr>
<tr>
<td>d)</td>
<td>Idler arrangement</td>
<td>± 2 mm in vertical plane</td>
</tr>
<tr>
<td>e)</td>
<td>Rail mounted equipment like trippers, shuttle conveyor etc. in longitudinal direction of the same rail</td>
<td>2 mm /m of rail</td>
</tr>
<tr>
<td>f)</td>
<td></td>
<td>5 mm/ 25 m of rail</td>
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<tr>
<td></td>
<td></td>
<td>15 mm Max.</td>
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</tbody>
</table>
01.04 Performance Tests & Guarantee Parameters

I. After the equipment are completely erected at Purchaser’s site, each item/ equipment will be thoroughly inspected for correctness and completeness of the installation and they shall be subjected to final tests as to performance and guarantee to be carried out in the presence of Contractor and the Purchaser / MECON to demonstrate that the performance of the equipment conforms to relevant standards and specifications and meet the requirements as given in this specification. The tests/ checks to be conducted shall be generally as under:

II. For each equipment, the load test shall be conducted in stages. The equipment shall be run for 8 to 10 hours continuously (cumulatively) at no load, 25%, 50%, 75%, 100% of the rated capacities or at rate mutually agreed upon between Contractor and Purchaser / MECON. The intervening period shall be available for making adjustments and arrangements by the Contractor as may be required.

III. All the specified speeds of the equipment shall be measured under full load conditions.

IV. Proper operation of all positional limit switches for shuttle conveyor and all safety switches for cable reeling drums, limit and safety switches/ alarm for conveyors like pull cord switch, zero speed switch, belt sway switch etc. shall be demonstrated by the Contractor in the presence of Purchaser / MECON.

V. During operations of the equipment at no load and at full load, performance of all the drives shall be checked in respect of current drawn by the motors, temperature rise, vibrations, gear box noise and its heating, bearing heating etc. consumption of power and various consumptions like lubricants etc. shall also be measured and compared with the respective rated values.

VI. Any other observations/ tests felt necessary for judging the performance of the machines and mutually agreed between Contractor and Purchaser shall be carried out.
VII. If during the test runs, there is an interruption exceeding 2 hours due to any cause other than power failure or shortage of input materials for which the Purchaser is responsible, the test run shall be discontinued and fresh date shall be decided mutually by both the parties.

VIII. The equipment shall be considered to have performed satisfactorily when

i) Rated capacity of equipment is demonstrated with all its drives and accessories functioning properly over a minimum period of eight (8) hours.

ii) It runs successfully for a continuous period of 15 days at the rated capacity.

iii) Successful reversing of reversible shuttle conveyors (if any) on load.

01.05 Drawings / Document / Information to be furnished by Tenderer

The number of copies of drawings/ data and other documents shall be as per General Technical Specification (GTS).

1 List of drawings /data to be submitted along with tender

a) General arrangement drawing of conveyors/ shuttle conveyors etc. showing overall dimension, profile, idler spacing, take-up arrangement, motor kW, drive arrangement etc. along with chutes, scraper, skirt boards, switches, wheel load, wheel spacing, wheel diameters, travel drive, power supply arrangement for travel drive etc.

b) General Arrangement of conveyor-equipment showing overall dimensions and weight as well as GA of motor with its component list.

c) Supplier's name for conveyor components (like idlers, pulleys, motors, and gearbox) catalogues for these items shall be furnished.

d) List of commissioning spares proposed by the Tenderer.

e) List of recommended spares for two years maintenance of plant and equipment along with itemised price.

f) Duly filled up questionnaire given below.

g) List of imported components in the equipment, if any.

2 List of drawings to be submitted for approval (by successful Tenderer)

Following design data, calculations and drawings shall be submitted by the Successful Tenderer to the Purchaser / MECON in stages for approval.

- All the drawings/ data listed in clause above, giving all the details, loads/ power requirement etc.
- Calculation of motor kW, gear box, coupling and pulley selection of shuttle conveyor.
- Technical parameters of shuttle conveyor in a tabulated form.
- In addition to the above, the Purchaser/ Consultant reserve the right to insist on submission of calculations/ drawings/ data for any mechanical, structural or electrical equipment/ component as required.

3 Drawing/data/calculation for reference (by successful Tenderer)
- Load data and foundation pedestal plan for head end, tail end, drive base frame etc., specially where the Junction House/building is provided by another supplier/purchaser.

- Wheel load diagram for shuttle conveyors.

- Any other load data/information required by Purchaser/MECON for design of building/structures.

- All drawings and documents approved by Purchaser/MECON as per GTS.

- Procedure for testing and commissioning. This shall also be furnished in soft copy.

- Spare part list and drawings

- Catalogues/literatures

- Operation and maintenance manual.

- Final test certificates

- As built drawings

- Ordering specifications for operating consumables/supplies

01.06  
**Questionnaire (To be filled by by Tenderer)**

The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

- **General**

01  Name and address of the Tenderer :

02  Previous experience of the Tenderer :

03  List of similar equipment supplied :

04  Whether the Tenderer has any technical collaboration with any other company/organisation for his equipment.

05  If answer to question .04 is yes, furnish the following details.

  a)  Name and address of the collaborator

  b)  Nature of the collaboration in detail

  c)  Previous experience of the collaborator

06  List of drgs./literatures enclosed with the offer.

- **Questionnaire for conveyors**

  i)  Conveyor no. :

  ii)  Carrying capacity (t/h) :
iii) Centre to centre horizontal distance (m)
iv) Belt width (mm)
v) Belt speed (m/s)
vi) Total weight of conveyor (kg)
vii) Pulley details
   Followings to be indicated for head, bend, snub, tail, take-up pulleys separately:
   a) Make
   b) Pulley diameter (mm)
c) Face width (mm)
d) Shell thickness (mm)
e) Bearing
   - Make
   - Expected life (hrs)
f) Weight (kg)
viii) Idlers
   The following to be indicated for carrying, cushion, return, SAC, SAR and transition idlers:
   a) Type (in-line / off set)
b) Diameter (mm)
c) Shell thickness (mm)
d) Tube specification
   (ERW / Seamless)
e) Max. roll eccentricity (mm)
f) Troughing angle
g) Bearing
   - Make
   - Expected life (hrs)
h) Weight (kg)
xix) Motors
   a) KW rating
   b) RPM
c) Type
e) Bearing
   Make
   Expected life (hrs)
x) Gear Boxes for belt drive and carriage travel
   a) Make
   b) Type
c) Reduction ratio
d) Torque rating (kg-m)
e) Overall efficiency
   f) Wt. of Gear box (kg)
xii) Couplings
   a) Make and type of high speed couplings
   b) Make and type of low speed couplings
<p>| | |</p>
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<tr>
<td>c) Weight (kg) :</td>
<td></td>
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<tr>
<td>xii) Take-up type :</td>
<td></td>
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<tr>
<td>xiii) Belt cleaners – type :</td>
<td></td>
</tr>
<tr>
<td>– Weight (kg) :</td>
<td></td>
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<tr>
<td>xiv) Pull chord switches (no. of pairs ) :</td>
<td></td>
</tr>
<tr>
<td>xv) Belt sway switches (no. of pairs ) :</td>
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<tr>
<td>xvi) Zero Speed Switches :</td>
<td></td>
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<tr>
<td>xvii) Brakes</td>
<td></td>
</tr>
<tr>
<td>a) No. and location :</td>
<td></td>
</tr>
<tr>
<td>b) Brake drum diameter (mm) :</td>
<td></td>
</tr>
<tr>
<td>c) Torque rating (kg-m) :</td>
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</table>
02 CRUSHERS

02.00 SCOPE OF WORK

1. The scope of work of the Tenderer shall consist of design, engineering, manufacture, inspection, assembly shop testing, painting at manufacturer's shop as well as at site after erection, packing, loading and transportation, supply at site, erection, testing and commissioning of the following crushers & vibration isolation system (if required).

The crusher shall be complete with individual drive, lubrication/ greasing arrangement and the control, wiring, panels, local control box.

2. Complete erection and commissioning of crusher and vibration isolation system including prestressing of vibration isolation elements, placing of elements in position, checking clearances in the shuttering of the RCC top deck, releasing of prestress in spring elements and making final adjustments and alignments after machine installation etc. including all grouting as required.

3. All fixing bolts& nuts including foundation bolts, brackets, supporting structures shall be included in the scope of supply of Tenderer.

4. All civil works, grouting of foundation bolts chipping, making holes or pockets, if any required for fixing crushers base plate, inserts etc and finishing work after chipping shall be in the scope of the Tenderer.

5. Spares for two years trouble free operation of each equipment. Lists of such spares along with item wise prices shall be furnished.

6. Required quantity of initial fill of oil, grease, lubricants, hydraulic fluid etc. and other consumable which are necessary for cleaning / flushing including erecting, testing and commissioning the crushers.

7. Necessary tools and tackles for each crusher required for maintenance, testing or inspection of the crusher or any of the installations on it List of such spares shall be furnished along with the quotation.

8. All miscellaneous items and spares required for commissioning of the crushers. The list of such spares shall be furnished along with the quotation.

9. Supply of insurance spares along with their list for each equipment.

10. All electrics/ electrical equipment as indicated under relevant clauses.

11. Statutory approval wherever required shall be taken by the Supplier for the equipment being supplied by them from relevant state/ central authorities.

12. The equipment supply shall be complete in all respect including its structural, mechanical and electrical components and standard accessories such as Roll Grinding attachment for Roll Crusher, Vibration isolation system of spring with damping pad for swing hammer reversible impactor/ Ring Granulator etc.

13. All items essential for the desired operation of the equipment, whether specifically mentioned in this specification or not, shall be included in the scope of work the Tenderer.
14. The scope of work shall stand supplemented by such details as are given in this specification/tender specification drawing, Instruction to the Tenderer, general conditions of contract or any other part of the tender document.

02.01 TECHNICAL SPECIFICATION

02.02.01 Roll Crusher

- The Roll Crushers shall be of robust construction and suitable for ease of maintenance. The housing shall be of welded construction with individually driven counter rotary crushing roll arrangement housed in a M.S. fabricated body. The frame shall be equipped with renewable, abrasion resistant liner plates of adequate thickness.
- Automatic gap adjustment of roll shells shall be provided.
- Roll shell shall be of replaceable type and made of chrome moly alloy steel.
- Automatic roll grinding system shall be provided for turning each crusher top & bottom rolls.
- The shaft shall be supported on antifriction bearings.
- Direct drive through fluid coupling and gear box shall be provided for driving the rolls.
- Centralised grease lubrication system shall be provided.
- Product analysis curve shall be provided justifying the selection of proper crusher.
- The crushers shall be designed so as to eliminate vibration when machine is running. The crusher shall be mounted on vibration isolation system.

02.02.02 Swing Hammer Reversible Impactor

- The swing hammer reversible impactors shall be of robust construction and suitable for ease of maintenance. The housing shall be of welded construction. The frame shall be equipped with renewable, abrasion resistant liner plates of adequate thickness. The hammers of the impactor shall be fitted to the disc mounted on the rotor shaft and inner surface of impactor shall be provided with replaceable breaker plates. Life of hammer shall be min. four lakh tonnes of material crushed. The crusher shall be provided with arrangement for setting the required product size by suitable means.
- The crushers shall be designed so as to eliminate vibration when machine is running. The crusher shall be mounted on vibration isolation system.
- Suitable wear resistant lining of operating life minimum 2 years shall be provided in the housing.
- Material for the beater heads & grinding gibs shall be annealed chrome moly steel.
- Power transmission to the crusher shall be complete with V-belt drive, which includes motor, sheaves, drive sheaves, fluid coupling, belts and guards, motor base, pedestal bearings, hydraulics & other necessary items. The hammer shall be reversible.
• All bearings shall be provided with adequate dust seals & the bearing shall preferably be of special roller type. Protection hood shall be provided for coupling.

• All the parts shall be easily accessible for maintenance and repair. Inspection door shall be provided wherever needed. The drive unit shall ensure smooth starting & running. Extra insulations shall be used to limit the noise level.

02.02.03 Rod Mill

• Rod mills shall be provided for secondary crushing/ grinding. The rod mills shall be of robust construction with provision of feeding the material from end. It shall be of welded construction complete with drive arrangement through motor, fluid coupling, gear box, brake and open girth gear. The shell shall be made of mild steel lined with suitable replaceable liners with sub-lining so that noise level does not exceed 85 db. The shell shall be provided with manhole & openings for the end peripheral discharge.

The Tenderer shall guarantee that the noise level will be limited to 85 db at a distance of 1.5 metre from the machine.

• The rod mills shall be of rugged design. The wearing out parts of the crusher shall be easily replaceable. The crusher shall preferably be designed such that it is protected against damage due to entry of foreign material. Alternatively, additional system shall be provided to prevent the entry of such foreign material into the rod mill.

The design of rod mill shall be such that wear of crushing components can be easily compensated and the same will not affect or upset either the product sizing or its capacity. The Tenderer shall ensure the availability of replaceable wear parts. The rod mill shall be provided with the inching device with separate drive.

• Automatic centralized lubrication system shall be provided for main supporting bearing and automatic spray for gear drive unit, ring gear, metering grease pump for the trunion bearings with labyrinth, seals & pinion shaft bearings. Necessary piping with couplings and connections are also included in the scope of work. Necessary instruments, valve etc. mounted on a panel shall be provided.

• 360 degree sectionalized guard of steel plate for ring gear and pinion shall be provided with inspection door and felt seals on both sides of the ring gear. The guards shall also be equipped with clean out and drain openings.

02.02.04 Ring Granulator

• The crusher shall have a frame adequately designed for the service intended with large quick opening inspection doors, fitted with dust tight seals. The frame shall be equipped with renewable, abrasion resistant liner plates of adequate thickness.

• The cage shall be supported on top by a heavy hinged shaft and it shall be provided with means for adjustment to control output size and also to compensate for wear and tear of screen plates and crushing rings. The breaker plates and screen plates provided shall be of abrasion-resistant renewable type manganese steel conforming to IS: 276:1992 grade-III. The opening of the screen plate shall be so designed as to allow free flow of crushed material even with the maximum percentage of moisture specified. The crusher cage shall be adjustable with hydraulic cylinders.

• The rotor assembly shall consist of forged and heat treated alloy steel shaft and abrasion
resistant manganese steel, suspension disc which shall be keyed to the shaft. Suspension bar support adequately designed rings. The crusher rings shall be made of work hardening type manganese steel conforming to IS-276 grade-III, 1992.

- The crusher shall be provided with a tramp iron trap (deflector plate and access door), to prevent uncrushable material from being brought back into the crushing cycle.

- The crusher bearings shall be spherical roller type with provision for grease or oil lubrication. In case of oil lubrication, supply of oil pump along with pipes, temperature & pressure gauges & control panel to be included in the scope.

- The drive unit shall be complete with motor, fluid coupling and all other accessories.

- Crusher casing shall be provided with hinged inspection doors of minimum 300 x 200 mm on top. There shall be arrangement to lift the top half of crusher for inspection/ maintenance.

- The crushers shall be designed so as to eliminate vibration when machine is running. The crusher shall be mounted on vibration isolation system

02.02 Drawings / Document / Information to be furnished.

1. List of drawings /data to be submitted along with tender
   a. Tender shall be accompanied by general arrangement drawings for crushers, auxillaries & vibration isolation system showing to scale the elevation, side view and plan along with information such as clearances, arrangement and disposition of all drives and other equipment installed on the crusher. Crusher weight, wt. of heaviest single piece, motor kw, drive arrangement, control system write up and important technical features of the crusher offered and the load data of individual crushers, auxillaries & vibration isolation.

   b. Tender shall be accompanied with details of spring & damping pad arrangement with all literature/ catalogues.

   c. List of commissioning spares proposed by the Tenderer.

   d. List of operational spares recommended for two year normal operation, insurance spares and list of tools and tackles to be supplied with the equipment.

   e. Duly filled up questionnaire given below.

   f. List of operational spares recommended for two year normal operation, insurance spares

   g. Data sheet for noise protection.

2. List of drawings to be submitted for approval
   a) Drawings listed hereinafter shall be submitted to the Purchaser/his consultant in stages for approval, starting within one month of issue of letter of intent and prior to the commencement of fabrication.

   The load data/ drawing must be submitted within one month of issue of letter of intent.
b) General arrangement drgs drawn to the scale and containing all information’s as described elsewhere along with civil load data for individual equipment.

d) Assembly drawings of individual drives

e) Technical characteristics of crushers in a tabulated form, characteristic curves.

f) In addition to the above, the Purchaser/consultant reserves the right to insist on the submission of calculation and/or drawings for any mechanical, structural and electrical components as required.

g) Submission of detailed design calculations, analysis (static and dynamic) and drawings for Purchasers acceptance and approval. All documents and drawings shall be supplied in copies and two reproducible. All calculation shall be submitted in sets.

3. **Drawings / data/ calculations for reference**

01. Civil load data drgs for Crushers
02. Hydraulic circuit drgs for Crushers and for each system, lubrication arrangement etc.
03. Parts list, bill of materials and material specification.
04. Major sub assembly drgs of drives.
05. G.A of grinding attachment for roll crushers.
06. G.A of greasing systems for crushers.
07. Hydraulic circuit for door opening for swing hammer reversible impactor
08. Oil lubrication system for Rod mills.
09. Grease spraying system for Rod mills.
11. P & I diagram for Rod Mills, swing hammer reversible impactor and roll crushers.
12. a) Furnishing methodology of providing shuttering for the deck structure and its removal, installation of springs and dampers isolation system.
    b) Furnishing installation and maintenance manual indicating all erection sequences and details of maintenance of equipments, procedure etc. necessary for installation, maintenance of vibration isolation system and the detail specification of various spares required for 5 years operation of the plant.
    c) Furnishing bill of materials of various elements such as springs, visco dampers with their rating, stiffness etc.
    d) Furnishing detailed specification of the vibration isolation system and various items indicated in the supply and standard national or international code to which they conform to.

13. Drawings of all wearing out parts.


4. **Contract drawings and documents to be furnished along with the supply:**

i/ Erection drawings, erection specification & erection instructions
ii/ Instruction for storage and reconservation including those for electrical, instrumentation and communication items
iii/ Performance data
iv/ Test charts and inspection certificates in bound volume
v/ Operation & maintenance manuals
vi/ Safety manuals
vii/ List of spares for 2 year's normal operation/maintenance
viii/ Manufacturing drawings and bill of materials for all spares and wearing parts (excluding those for proprietary items)
ix/ Ordering specs. including catalogues and details for all spares (including proprietary items) along with spare lists.
x/ Ordering specifications for operating consumables/supplies
xi/ All as built drawings, in bound volumes incorporating approved changes if any made during erection and commissioning, shall be supplied progressively within two months of commissioning of the (all drawings are to be furnished even if there is no change) equipment.
xii/ Classified list of drawings in A4 size.

02.03  
Questionnaire to be filled by Tenderer.

The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

01.  Name and address of the Tenderer :  
02.  Previous experience of the Tenderer :  
03.  List of similar equipment supplied  
    along with user’s certificate  
04.  Is it the Tenderer's intention, if awarded :  
    the contract, to comply fully in all respects  
    with Purchaser’s specifications covering  
    the work? If not, he shall state specific  
    exception in details.  
05.  Location / Nos. off  
06.  Designation  
07.  Capacity through.  
08.  Material (input & product) details.  
09.  Drive details & rating (kW, rpm etc.)  
10.  Material of construction for various parts  
11.  Liner material used, type, thickness, fixing arrangement.  
12.  Product size adjustment methodology  
13.  Control details  
14.  Gross weight of equipment (t) and weight of individuals parts  
15.  Weight of heaviest part  
16.  Foundation load data  
17.  Duty
18. Special features if any

19. Any other information as the tenderer thinks necessary for installation

20. Details of vibration isolation system
03.01 SCOPE OF WORK

1. The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser's site, unloading, handling and storage at site, insurance during storage, erection, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of screens.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

2. The scope of supply and services of the Tenderer shall include the following:

a) Mechanical
   – Each equipment shall be complete in all respect including, its drive units, cables, safety switches, hoods, sealing materials, structural, mechanical and other standard accessories.
   – Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment & drive with floor / bins.

b) All Electricals and controls

3. All fixing bolts and nuts including foundation bolts shall be included in the scope of supply of Tenderer.

4. Statutory approval wherever required shall be taken by the Tenderer for the equipment being supplied by them from relevant state/ central authorities.

5. Tenderer shall furnish necessary technical supervisory personnel to supervise the erection; testing, commissioning & PG test. The assembly of the equipment shall be made in such a way that while handling/erection of the equipment at site no problem is encountered. Erection mark of such assembly shall clearly be marked to facilitate the erection of the equipment.

6. The Tenderer shall submit detailed proposals setting forth his terms, conditions and fees for rendering the following services.

7. Training of Purchaser's personnel in all branches connected with the operation and maintenance of the equipment.

8. The scope of work shall stand supplemented by such details as are given in this specification, tender drawing, and instruction to the Tenderer, General Conditions of Contract (GCC), or any other part of the document.
03.02 TECHNICAL SPECIFICATION

1. General

All equipment shall be designed, manufactured, supplied, erected, tested and commissioned in accordance with relevant Indian Standards and International Standard where applicable in addition to the requirement mentioned herein.

The Supplier shall make his own calculation in respect of motor kilowatt to ensure satisfactory performance of the equipment.

Adequate no. of locating pins and match marking shall be provided for easy assembly and dismantling of the equipment.

Standardisation of components and assemblies shall be carried out to the maximum possible extent to ensure interchangeability.

All equipment shall be designed such that all components are easily accessible for inspection, repair and maintenance.

2. Equipment Specification (Mechanical)

a) The screen shall be of continuous duty type, robust construction and shall be fabricated from steel plates and structural of adequate strength and of balanced design. All welded parts will be stress relieved and all holes will be drilled and not punched. Sharp edge on screen body will be avoided. The screen body will be adequately reinforced at supporting points where vibrating mechanism is connected to the screen body. It will be provided with suitable back plate at feed end to prevent spillage of material. The screen body will be supported on adequate number of springs to give adequate rigidity to the equipment as well as transmission of dynamic force to the supporting structure will be minimum, to the extent possible. The springs will have fixed spring-constant throughout its operating range. It shall be floor mounted inclined at 8 degree (max.) with horizontal and installed as per design requirement.

b) Screening surfaces shall be adequate to render 95% efficiency of screening.

c) The tenderer shall offer the linear motion screen with the direct force exciter (DFE) until and unless the requirement changes due to specific technical reasons. The motion to DFE shall be imparted through cardon shaft. Other type of screens shall be specifically mentioned in the data sheet.

d) The screen shall have in-built design feature to overcome the additional load likely to occur when the screen passes through the resonance zone. Such momentary additional loads shall not be transferred to the supporting building structures.

e) Wherever applicable the screen shall be provided with heavy duty, self-aligning, spherical double row roller bearings in such a manner as would reduce maintenance and refitting time. The load distribution due to eccentricity shall be such so as to minimise shaft deflection and prevent misalignment of bearing races. The bearings shall be protected from dust effectively by dust tight seals and provided with pressure type lubrication.

f) The screen deck shall be totally covered.

g) The screen shall be provided with non-clogging screen cloths/ plates. Screen cloth/ plates
support will be suitably planned / devised so that the distance between the supports is uniform and proper chamber is obtained. The clamping arrangement shall be suitable to hold the cloth/ plate at proper tension and also allow easy changing.

Screen will be having secondary induced vibration of screen cloth/ plate to minimise the choking. The selection of bed area will be done in such a way that the bed depth is limited to reduce the choking.

h) The vibrating springs of the screen shall be high quality chrome vanadium steel.

i) In order to prevent deterioration of the materials being screened, relatively high speed, low amplitude vibration of the screen shall be preferred.

j) The drive shall be such that no unwanted vibration forces are transmitted to the stationary structure. The screen shall be designed for smooth starting and stopping without excessive bouncing.

03.03 DOCUMENTATION

1 List of drawings /data to be submitted along with tender

The Tenderer shall submit adequate sets of following technical drawings & technical data/ information with tender for vibrating screens without which the tender shall be considered as incomplete & may not be considered for acceptance.

a) General description of design consideration and all the assumption made by the supplier.

b) Specification of individual equipment indicating capacity (rated and designed), dimension, drive ratings, safety factors, drive details, duty rating, weight of individual equipment, weight of heaviest part, etc.

c) Make and model of equipment/parts/components.

d) Specification of materials of construction of major parts/ components along with standards and chemical composition.

e) Catalogues/leaflets for all equipment including bought-out items. Details of bought-out items with makes shall be given separately.

f) G.A. drgs for the equipment/ system including sections and details giving relevant information, binding dimension, loads for designing civil/structural works etc.

g) Standard/ special accessories being considered for supply along with the equipment.

h) Requirement of tools and tackles for erection and maintenance.

i) Requirement of utilities and services.

j) Deviation from tender document.

k) Duly filled in questionnaire

2 List of drawing/documents to be furnished by the Successful Tenderer
The following drawing/document shall be submitted by the Successful Tenderer within one month of placement of order:

a. General arrangement drawing of equipment showing full details of screens, feeders, chutes, hoods etc in plan and section along with design calculations.

b. Calculation sustaining the screen / feeder size selection and motor power calculation

c. Foundation outline drawing with load data, pocket sizes and location, foundation bolts and inserts details as required.

d. Fixture details, load data and special erection instruction with allowable tolerances as required.

e. Specification of oils and lubricants and other consumables and their quantity and frequency of change.

f. Motor list including kW rating

g. Technical data sheet

3 List of drawings/ documents to be furnished along with equipment by the Successful Tenderer.

a. Sets of all Approved GA drawings and motor data sheets, complete assembly and sub assembly drawings of the equipment together with one copy of good quality polyester reproducible.

b. Drawing of all equipment/ component received from sub supplier together with one copy of reproducible.

c. Engineering and design calculations

d. Test and warranty certificate for each item of equipment

e. Detailed erection schedule and manuals, assembly/ erection drawings, erection sequence, special precautions to be followed during assembly/ erection (these shall be despatched three months prior to FOT /FOR delivery)

f. Test reports and inspection reports

g. Instruction manuals for testing and commissioning

h. Operation, maintenance and safety manuals

i. Requirement of special tools and tackles, if any, for subsequent maintenance

3. Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions.

4. List of spare parts with drawings, sketches, specifications and manufacturer’s catalogue (two sets and one reproducible and/or two sets of catalogues)

03.04 QUESTIONNAIRE
The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

21. Name and address of the Tenderer :

22. Previous experience of the Tenderer :

23. List of similar equipment supplied along with user's certificate :

24. Type of screen :

25. Location / Nos. off :

26. Capacity through :

27. Drive details & rating (kW, rpm etc.) :

28. Deck size (mm x mm), Panel size & inclination :

29. Material of construction of deck plate & other parts :

30. Liner material used, type, thickness, fixing arrangement :

31. Screen cloth/plate specification and type of perforation :

32. Control details :

33. Gross weight of equipment (t) and weight of individuals parts :

34. Weight of heaviest part :

35. Foundation load data for screens & feeders for design of building :

36. Duty :

37. Special features if any :

38. Any other information as the tenderer thinks necessary for installation :

39. Guarantee efficiency of the screen :

40. Details of spring, i.e. material composition, wire dia, free length etc. :

41. Whether anti-vibration pads have been provided below spring base plate :

42. a) Stroke and amplitude of vibration :

b) Limits of adjustment of amplitude & stroke :

43. Gear Boxes
   a) Make :

b) Type :

c) Reduction ratio :

d) Torque rating (kg-m) :

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<tr>
<td>e) Overall efficiency</td>
<td>:</td>
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<td>f) Wt. of Gear box (kg)</td>
<td>:</td>
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</table>

44. Couplings
   a) Make and type of high speed couplings : 
   b) Make and type of low speed couplings : 
   c) Weight (kg) : 

26. Bearing
   Make : 
   Expected life (hrs) : 

04 VIBRO FEEDERS

04.01 SCOPE OF WORK

1. The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of Vibratory feeders as covered under this specification.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

2. The scope of supply and services of the Tenderer shall include the following:

   - Mechanical
   - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, structural, mechanical and other standard accessories.
   - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment and feed chute.
   - Electricals and controls

3. All fixing bolts and nuts including foundation bolts shall be included in the scope of supply of Tenderer.

4. Two years maintenance spares.

5. Commissioning spares as required during testing and commissioning of the equipment.

6. Insurance spares.

7. Required quantity of initial fill of oil, grease, lubricants, hydraulic fluid etc. and other consumables which are necessary for cleaning/flushing including erection, testing and commissioning the equipment shall be in the scope of supply of the Tenderer.

8. Necessary tools and tackles for each equipment required for maintenance, testing or inspection of the equipment.

9. Statutory approval wherever required shall be taken by the Tenderer for the equipment being supplied by them from relevant state/central authorities.

10. The scope of work shall stand supplemented by such details as are given in this specification, tender drawing, and instruction to the Tenderer, General Conditions of Contract (GCC), or any other part of the document.
04.02 TECHNICAL SPECIFICATION

1. General

All equipment shall be designed, manufactured, supplied, erected, tested and commissioned in accordance with relevant Indian Standards and International Standard where applicable in addition to the requirement mentioned herein.

The Supplier shall make his own calculation in respect of motor kilowatt to ensure satisfactory performance of the equipment.

Standardisation of components and assemblies shall be carried out to the maximum possible extent to ensure interchangeability.

All equipment shall be designed such that all components are easily accessible for inspection, repair and maintenance.

2. Equipment Specification (Mechanical)

a. Vibratory feeders shall be of generally electro-mechanical type (any other type shall be indicated in data sheet for respective equipment). The vibrating units of the feeders shall be of unbalanced motor type. The vibrating feeders and their mounting arrangement shall be properly designed to suit the scheme shown in the TS drawing. It shall be ensured that no vibration is transmitted to the supporting/ surrounding structures. The troughs of the feeders shall be of tray type construction and shall be made out of minimum 6 mm thick MS plate (IS: 2062-1992). 10 mm thick liner (SAIL Hard) shall be provided inside the trough along its length and cross section. The trough liner shall be provided with adequate side guard to avoid spillage. The trough shall be covered with dust tight hoods with provision of cut out and flange for dust extraction. The equipment will be provided with enclosed dust proof vibrators (un-balanced masses).

b. All the feeders shall be of suspended type unless otherwise mentioned in data sheets. Each vibrating feeder shall be supplied complete with supporting structures, feed chutes, manually operated feed control gates, hood cover, electrics, plates and fixing nuts and bolts, suspension rods, ropes, turn buckets etc.

c. The successful Tenderer shall ensure that minimum amount of assembly will be required for erection and commissioning of equipment at site. Site welding etc. shall be avoided as far as possible.

d. The feeders shall be of robust construction and of balanced design.

e. SAIL hard liner of 10 mm thick shall be provided in feed chute

f. All bolts except those with nyloc nuts shall be provided with lock nuts and spring washers.

g. No cast iron parts shall be used (except for pillow block)

h. Equipment shall be designed such that all components are easily accessible for inspection, repair and maintenance.
04.03 DOCUMENTATION

a) List of drawings/data to be submitted along with tender

b) General arrangement drawing with bill of material of equipment showing overall dimension, motor kW, drive arrangement etc. along with load data, weight etc.

c) Supplier's name for components (like motors, coupling, gearbox etc.) catalogues for these items shall be furnished.

d) List of commissioning spares proposed by the Tenderer.

e) List of recommended spares for two years maintenance of plant and equipment along with itemised price.

f) List of tools and tackles to be supplied with the plant and equipment.

g) Duly filled up questionnaire.

h) The Tenderer has to furnish one copy of the specification drawing duly signed by him as a token of acceptance along with the list of deviation from tender documents.

04.04 QUESTIONNAIRE

The Tenderer shall furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

01. Name and address of the Tenderer : 

02. Previous experience of the Tenderer : 

03. List of similar equipment supplied along with user’s certificate : 

04. Is it the Tenderer's intention, if awarded The contract, to comply fully in all respects with Purchaser’s specifications covering the work? If not, he shall state specific exception in details. : 

05. Location / Nos. off : 

06. Type of feeder & Designation : 

07. Capacity through : 

08. Material of construction of different parts : 

09. Total weight and weight of individuals parts : 

10. Type of liner and thickness : 

11. Motors
   a) KW rating : 

b) RPM  

Expected life (hrs)  

12. Gear Boxes  
a) Make  
b) Type  
c) Reduction ratio  
d) Torque rating (kg-m)  
e) Overall efficiency  
f) Wt. of Gear box (kg)  

13. Couplings  
a) Make and type of high speed couplings  
b) Make and type of low speed couplings  
c) Weight (kg)
05  VIBRATORY GRIZZLY FEEDERS

05.01  Scope

9. The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of screens.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

10. The scope of supply and services of the Tenderer shall include the following:
   a) Mechanical
      - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, hoods, sealing materials, structural, mechanical and other standard accessories.
      - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment & drive with floor / bins.
   b) All Electricals and controls

05.02  Technical Specification

1. Code & Standards

The design, manufacture, inspection and testing of Vibrating Grizzly Feeder shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Vibrating Grizzly Feeder shall conform to the latest edition of standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility.

2. Technical requirement

1. The vibrating grizzly feeder shall be of mechanical type.

2. The grizzly feeder shall be capable to segregate the desired size of material. The width of vibrating grizzly feeder shall match to feed the material uniformly over the entire length of subsequent equipment.

3. The screening area excluding solid deck area shall be minimum 0.75 m$^2$ per 100 tonnes/hr of incoming feed. Inclination of the grizzly pan shall be so selected so as to ensuing proper flow ability of material on the deck without any hindrance.

4. The equipment shall be designed in such a manner that choking does not occur during operation, particularly during rainy season when the coal gets sticky.
3. **Constructional Features**

1. The deck of vibrating grizzly feeder shall have continuous solid deck section in the impact zone under direct coal fall and remaining deck shall be fitted with perforated deck assembly.

2. The solid deck section shall be provided with replaceable SAIL HARD or equivalent liner plate of adequate thickness.

3. The perforated deck shall be wear resistant and shall be rigidly fixed with main frame along the length of grizzly deck.

4. The Vibrating Grizzly feeders shall be mounted on the floor with the help of helical springs made of alloy steel. No rubber / synthetic material for the support shall be provided.

5. Suitable sealing arrangement shall be provided between the vibrating structure and chute work to avoid dust nuisance in the surrounding area. Proper arrangement to avoid dust ingress into lubricant of eccentric shafts shall be provided. Necessary arrangements shall be provided for maintaining the complete vibratory assembly.

6. In case V-belt drive to avoid loosening of sheave mounted on eccentric shaft, suitable arrangement like taper bush or dobicon coupling shall be provided. Marker plate to indicate stroke length and stroke angle shall be provided.

05.03 **Drawing & documents to be submitted by the successful bidder**

1. List of drawings /data to be submitted along with tender

The Tenderer shall submit adequate sets of following technical drawings & technical data/information with tender for vibrating screens without which the tender shall be considered as incomplete & may not be considered for acceptance.

a) General description of design consideration and all the assumption made by the supplier.

b) Specification of individual equipment indicating capacity (rated and designed), dimension, drive ratings, safety factors, drive details, duty rating, weight of individual equipment, weight of heaviest part, etc.

c) Make and model of equipment/parts/components.

d) Specification of materials of construction of major parts/ components along with standards and chemical composition.

e) Catalogues/leaflets for all equipment including bought-out items. Details of bought-out items with makes shall be given separately.

f) G.A. drgs for the equipment/ system including sections and details giving relevant information, binding dimension, loads for designing civil/structural works etc.

g) Standard/ special accessories being considered for supply along with the equipment.

h) Requirement of tools and tackles for erection and maintenance.
i) Requirement of utilities and services.

j) Deviation from tender document.

k) Duly filled in questionnaire

2 List of drawing/documents to be furnished by the Successful Tenderer

The following drawing/document shall be submitted by the Successful Tenderer within one month of placement of order:

a. General arrangement drawing of equipment showing full details of screens, feeders, chutes, hoods etc in plan and section along with design calculations.

b. Calculation sustaining the screen / feeder size selection and motor power calculation

c. Foundation outline drawing with load data, pocket sizes and location, foundation bolts and inserts details as required.

d. Fixture details, load data and special erection instruction with allowable tolerances as required.

e. Specification of oils and lubricants and other consumables and their quantity and frequency of change.

f. Motor list including kW rating

g. Technical data sheet

3 List of drawings/documents to be furnished along with equipment by the Successful Tenderer.

a. Sets of all Approved GA drawings and motor data sheets, complete assembly and sub assembly drawings of the equipment together with one copy of good quality polyester reproducible.

b. Drawing of all equipment/ component received from sub supplier together with one copy of reproducible.

c. Engineering and design calculations

d. Test and warranty certificate for each item of equipment

e. Test reports and inspection reports

f. Instruction manuals for testing and commissioning

g. Operation, maintenance and safety manuals

h. Requirement of special tools and tackles, if any, for subsequent maintenance

5. Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions.
General Technical Specification

6. List of spare parts with drawings, sketches, specifications and manufacturer's catalogue (two sets and one reproducible and/or two sets of catalogues)

05.04 QUESTIONNAIRE

The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

01. Name and address of the Tenderer : 

02. Previous experience of the Tenderer : 

03. List of similar equipment supplied along with user's certificate : 

04. Is it the Tenderer's intention, if awarded the contract, to comply fully in all respects with Purchaser's specifications covering the work? If not, he shall state specific exception in details.

05. Location / Nos. off 

06. Designation 

07. Capacity through 

08. Drive details & rating (kW, rpm etc.) 

09. Deck size(mm x mm), Panel size & inclination 

10. Material of construction of deck plate & other parts 

11. Liner material used, type, thickness, fixing arrangement. 

12. Screen cloth/plate specification and type of perforation 

13. Control details 

14. Gross weight of equipment (t) and weight of individuals parts 

15. Weight of heaviest part 

16. Foundation load data for screens & feeders for design of building 

17. Duty 

18. Special features if any 

19. Any other information as the tenderer thinks necessary for installation 

20. Guarantee efficiency of the screen 

21. Details of spring, i.e. material composition, wire dia, free length etc.
22. Whether anti-vibration pads have been provided below spring base plate

23. a) Stroke and amplitude of vibration  
b) Limits of adjustment of amplitude & stroke

24. Gear Boxes  
a) Make :  
b) Type :  
c) Reduction ratio :  
d) Torque rating (kg-m) :  
e) Overall efficiency :  
f) Wt. of Gear box (kg) :

25. Couplings  
a) Make and type of high speed couplings :  
b) Make and type of low speed couplings :  
c) Weight (kg) :

26. Bearing  
Make :
Expected life (hrs) :
06 GATES

06.01 SCOPE OF WORK

1. The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site of the equipment.

   The scope of the Tenderer shall also be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

2. The scope of supply and services of the Tenderer shall include the following:
   3. All fixing bolts and nuts shall be included in the scope of supply of Tenderer.
   4. Two years spares for each type of gates.
   5. Commissioning spares as required during testing and commissioning of the conveyor system.
   6. The scope of work shall stand supplemented by such details as are given in this specification, tender drawing, and instruction to the Tenderer, General Conditions of Contract (GCC) or any other part of the document.

06.02 TECHNICAL SPECIFICATION

1. Only the broad specifications covering the technical requirements for the equipment to be supplied are indicated. It is not the intent of this specification to specify complete details of the equipment including design and manufacture. The Successful Tenderer shall carry out detailed design, engineering and manufacture in a manner that shall ensure smooth and trouble free performance of the equipment as a whole.

2. The Tenderer shall ensure that minimum amount of assembly is necessary for erection and commissioning of equipment at site. Site welding shall be avoided as far as possible.

3. All components shall be designed and tested in accordance with latest Indian Standards unless stated otherwise & agreed to.

4. All components shall be manufactured with material of approved quality & best of workmanship. The equipment shall be shop assembled for checking operation and accuracy of parts

5. All working parts of the equipment shall be suitably located for convenient operation, inspection, lubrication, repairs & easy replacement

6. Rod gates shall be fitted between the bunker & equipment below like feeder/screens etc. to control the feed rate and to isolate the equipment from the bunker during maintenance. The gate shall be normally in partial/full open position and shall be controlled manually. The gates shall be fabricated from rolled steel. All rods shall be of diameter that ensures no bending. The spacing between rods shall be decided based on size of material stored in hopper/bin & direct material load. The tapered ends of the rod shall rest on square bars placed beyond zone of discharge. A tray shall be provided on the hopper for storing the rods.
7. **Sector gates** shall be fitted below bins/ bunkers and shall be manually operated to regulate the discharge of material from the bins/ bunkers. Sector gates shall be constructed out of materials having good resistance against impact and sliding wear rolled plates St 58 HT (IS: 961 – 1975) after hardening and tempering to HRC 25-30, shall be used. The material of pin shall be C-40 (IS: 1570 – 1979). The sector gears used shall be made of cast steel grade 23-24 (IS: 1030 – 1989) or EN-8 or equivalent and the teeth shall match perfectly to render noiseless and smooth service in operation. Wear resistant liner plate of suitable material shall be provided. Liner shall be provided on the gate main body and bottom portion. Anti-friction ball and roller bearings shall be used throughout.

- All bolts except those with nyloc nuts shall be provided with grip lock nuts or washers. Stud or body bolts shall not be used as fasteners for mechanical items.

- Manual lubrication nipples shall be provided for all the bearings.

8. The **motor operated flap gates** shall be provided in transfer chutes as specified and shall be complete with electrically operated actuators. The gates shall be of robust construction and suitable for trouble free operation.

- The flap gates shall be used to divert the flow of material received from feeding conveyor to the receiving conveyors. The gates shall be operated by an electromechanical linear actuator. The actuators will be mounted on the chute body/ or on a working / maintenance platform. The exact mode of support will be intimated to the successful Tenderer.

- The gate shall be fabricated out of 10 mm thick MS plates with wear resistant, replaceable liners. The liners will be bolted by counter sunk bolts. The thickness of the liners shall be adequate so as to give minimum 3 years operating life.

- The gate shall be capable of changing the direction of material on remote mode of control even when the material is being discharged from the feeding conveyor pulley.

- The equipment shall be capable of being operated for at least 15 switchings per hour at rated load and thrust and shall be suitable for 10 Nos. consecutive switchings at rated load and thrust. The equipment shall be shop tested to prove the requirement.

- The motor rating for the actuator shall be so selected as to provide sufficient thrust (min. 2500 kg) for operation of the flap gates against the moving weight of material and/or flap gate.

- The flap gate travel shall be in the range of 60° to 70°. Limit switches shall be provided to indicate extreme positions. Lever arm shall be provided between actuator and flap gate shaft for obtaining required thrust. Each gate shall be provided with a shaft, a hand lever and self aligning type anti-friction bearings with adequate sealing for dust proofing.

- The actuators shall be capable of preventing any over travel. Suitable travel dependent limit switches controlling the travel; of the flap gates on either direction shall be provided. These shall be placed internal to the drive unit and shall be completely dust-proof. The limit switches shall be capable of adjustments to vary to total length of travel of the gates.

- Suitable thrust dependent limit switches shall be provided. This shall trip off the actuator motor in case of excessive thrust due to jamming the gates during its travel in either direction.
9. **Rack & Pinion Gates** shall be of two types, i.e. motorised actuator operated or manually operated. All clauses below under “Motorised Rack & Pinion Gate” shall be applicable for manually operated Rack & Pinion Gates also, except that the mode of operation shall be manually and hence actuators, drives etc. are only for the motorised type.

10. **Motorised Rack & Pinion Gates**

- The gate shall be fitted in the transfer chutes between the bunkers / hoppers and feeders to control the feed rate to the feeder. During maintenance of equipment lying below the hopper / bunker, the gate shall be utilised for restraining fall of material from the hopper / bunker.

- The gate shall be normally in partial / full open position. Actuator shall be provided for opening & closing of the gate. In case of by-passing the actuator, the gates opening shall be controlled by the hand chains (manually).

- The actuator operated rack & pinion gates shall be suitable for closing and opening the gate with hopper / bunker full.

- All components shall be designed and tested in accordance with latest IS Specification unless stated otherwise and agreed to. In such case where Indian Standards are not available reputed International standards shall be followed.

- Rack and Pinion Gates shall be fabricated from rolled steel plates and section. It shall be complete in all respects including gates plate, frame work, operating chains, sprockets, gear rack and pinion, rollers etc. The gates plate shall have wear resistant liners and shall slide over rollers mounted on anti-friction bearings. The flap shall be properly stiffened to avoid distortion of flap. The flap shall be made of minimum 12 mm thick plates and lined. Material of construction for various elements shall be:-
Gate plate: Gate plates to be made from 20 thk ms plates conforming to IS : 2062 and to be suitably lined with sail hard plates of 16mm thk.

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<th>Material</th>
<th>Specification</th>
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<tr>
<td>Pin</td>
<td>C-45 / EN-8</td>
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<tr>
<td>Liner</td>
<td>Material SAIL HARD 16 thk. On Gate plate &amp; 10 thk. On side walls.</td>
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<tr>
<td>Rack</td>
<td>EN-8 / C-45 Hardness-225 BHN (min)</td>
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<td>Pinion</td>
<td>EN-8 / C-45 Hardness-250 BHN (min)</td>
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<tr>
<td>Roller</td>
<td>EN-8 on Ball bearing.</td>
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- The pull required to operate the gate manually (on actuator bypass) shall not exceed 25 kg when operating under a loaded bunker / hopper.
- All bolts except those with nyloc nuts shall be provided with grip lock nut or grip washers. Stud or body bolts shall not be used as fasteners for mechanical items.
- Gear boxes used shall be of approved make.

**06.03 DOCUMENTATION**

1. **List of drawings /data to be submitted along with tender**
   a. General arrangement drawing of each type of gates showing overall dimension, profile, material of construction, weight etc.
   b. List of commissioning spares proposed by the Tenderer.
   c. List of spares for two years operation.
   d. Duly filled up questionnaire.

2. **List of drawings to be submitted for approval by successful tenderer**

   Drawings listed hereinafter shall be submitted to the Purchaser/ MECON for approval, starting within one month of issue of letter of intent and prior to the commencement of fabrication.

   a) General arrangement drawing of each type of gates showing overall dimension, profile, material of construction, weight, bill of materials etc.

   b) In addition to the above, the Purchaser/ Consultant reserve the right to insist on submission of calculations/ for component selection.

3. **Drawing/data/calculation for reference to be submitted by successful tenderer**

   - Procedure for testing and commissioning.
   - Instruction for storage /erection, testing & commissioning.
   - Catalogues/literatures
   - Operation and maintenance manual.
   - Final test certificates

**06.04 QUESTIONNAIRE**
The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

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<td>01</td>
<td>Name and address of the Tenderer :</td>
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<td>02</td>
<td>Previous experience of the Tenderer :</td>
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<td>03</td>
<td>List of similar equipment supplied :</td>
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<td>05</td>
<td>List of drgs./ literatures enclosed with the offer. :</td>
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<tr>
<td>06</td>
<td>List of gates with details :</td>
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07 MOTORISED DIVERTER GATE

07.01 Scope

The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of Motorised Diverter Gates as covered under this specification.

The equipment shall be designed as per design criteria given below:

I. **Hierarchy of Specifications**
   a) Technical Specification
   b) General Technical Specification (GTS)
   c) IPSS & IS
   d) Indian Electricity Rules & statutory requirements of Central Govt. and State Govt.

Equipment complying with other recognised Standards such as IEC, BS, VDE, and IEEE will also be considered if it ensures performance equivalent to or superior to Indian Standards.

The components and materials used and the equipment supplied shall conform to high standards of design, engineering and workmanship and shall be suitable for efficient operation and reliable service in steel plant conditions.

II. **Design Basis**
   - Design capacity of equipment - 20% more than designed stream capacity of feed conveyor to be considered while calculating motor power
   
   - Pillow blocks
     a) Material - cast iron / cast steel
     b) Bearing - Self aligning spherical roller bearing
     f) Life - 40,000 working hrs (min.)
     g) Construction - Horizontal split type (one end fixed and the other end expansion type)

   - Reducer
     a) Service rating of 1.5 times the calculated shaft kW and thermal capacity of gear box shall be better or equal to that of motor
     b) Material - fabricated or cast steel
     c) KW rating shall be not less than 1.25 times the motor kW. Higher value of `a` or `c` will be considered
     d) No worm gear except for travelling gate

07.02 TECHNICAL SPECIFICATION
All equipment shall be designed, manufactured, supplied, erected, tested and commissioned in accordance with relevant Indian Standards and International Standard where applicable in addition to the requirement mentioned herein.

The Supplier shall make his own calculation in respect of motor kilowatt to ensure satisfactory performance of the equipment.

Standardisation of components and assemblies shall be carried out to the maximum possible extent to ensure interchangeability.

All equipment shall be designed such that all components are easily accessible for inspection, repair and maintenance.

The gate shall be capable to allow half flow on to each receiving conveyor or full flow on to one conveyor or to the other conveyor.

The gate casing shall be fabricated out of 6 mm thick MS plates with liners and conical portion of the diverter shall be made of 10 mm thick MS with 5 mm thick stainless steel/SAIL HARD liners. The gate shall move inside a totally enclosed steel framework mounted below the discharge hood of the feeding conveyor. Positive to and fro motion for the two positions shall be imparted to the gate supporting frame through rack and pinion arrangement driven by bevel geared drive. Material of construction of the pinion and rack shall be minimum C45 or EN8.

The gate shall be capable of changing the direction of material on remote mode of control even when the material is being discharged from the conveyor pulley.

The drive shaft shall be made of C45. Antifriction ball / roller bearings shall be used throughout.

Speed of the gate shall be 30 mm / sec.

Limit switches for positioning and position indication shall be provided.

Provision for manual operation of the gate shall also be provided at the extended motor shaft. Manual force required shall not exceed 25 kg.

Rubber buffers on the gate shall be provided at both ends inside the casing.

The gate shall be supported on the steel floor beams.

2 numbers inspection windows (hinged type and dust tight) shall be provided on drive side of the casing.

All bolts except those with nyloc nuts shall be provided with lock nuts or spring washers.

No cast iron parts shall be used (except for pillow blocks).

07.03 DOCUMENTATION

1. List of drawings /data to be submitted along with tender
a. General arrangement drawing of gates showing overall dimension, profile, material of construction, weight etc.
b. List of commissioning spares proposed by the Tenderer.
c. List of spares for two years operation.
d. Duly filled up questionnaire.

2. **List of drawings to be submitted for approval by successful tenderer**

   Drawings listed hereinafter shall be submitted to the Purchaser/ MECON for approval, starting within one month of issue of letter of intent and prior to the commencement of fabrication.

   a) General arrangement drawing of gates showing overall dimension, profile, material of construction, weight, bill of materials etc.
   b) In addition to the above, the Purchaser/ Consultant reserve the right to insist on submission of calculations/ for component selection.

3. **Drawing/data/calculation for reference to be submitted by successful tenderer**

   - Procedure for testing and commissioning.
   - Instruction for storage /erection, testing & commissioning.
   - Catalogues/literatures
   - Operation and maintenance manual.
   - Final test certificates

   a) For reference & records.
      i. Part list, bill of materials and specification.
      ii. Major sub-assembly drawings of drive, safety features, lubrication details etc.
      iii. List of spares, consumables, special tools and tackles.
      iv. Operation and maintenance manuals.

**07.04 Questionnaire**

The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

01. Name and address of the Tenderer :

02. Previous experience of the Tenderer :

03. List of similar equipment supplied along with user’s certificate :

04. Location / Nos. off

05. Designation
06. Capacity through
07. Material of construction of different parts
08. Total weight and weight of individuals parts
09. Type of liner and thickness
10. Motors
   a) KW rating : 
   b) RPM : 
   c) Type : 
11. Gear Boxes
   a) Make : 
   b) Type : 
   c) Reduction ratio : 
   d) Torque rating (kg-m) : 
   e) Overall efficiency : 
   f) Wt. of Gear box (kg) : 
12. Couplings
   a) Make and type of high speed couplings : 
   b) Make and type of low speed couplings : 
   c) Weight (kg) : 
08 WEIGH HOPPER

08.01 Scope Of Work

1. The scope of work of the Tenderer shall consist of design, engineering, manufacture, inspection, assembly, painting, supply and transportation to site, testing and commissioning of load cell mounted weigh hoppers, complete with rod gates, hydraulically operated gates, material Present Detector (MPD) and all accessories required.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

2. The scope of supply and services of the Tenderer shall include the following:
   a) Mechanical
      - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, structural, mechanical and other standard accessories.
      - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment & drive with floor / bins.
   b) All Electricals and controls

08.02 TECHNICAL SPECIFICATION

1. Each weigh hopper shall be provided with 3 nos. compression type strain gauge/ pressductor load cells and gates/ feeders as required for the application and indicated in the Technical Specification Data Sheet elsewhere.

2. The weigh hoppers shall be fabricated out of 10 mm thick (minimum) M.S. Plates (IS:2062-1992) and shall be of welded construction with one bolted joint for ease of maintenance/handling. Inner surface of the hopper shall be provided with Stainless steel (SS- 409) liners. Liner plates shall be bolted to the mother plates. Size and shape be such that handling is convenient.

3. The weigh hoppers shall be designed to discharge the required materials onto the conveyors uniformly in the specified discharge time in normal feed as well as choked feed condition. Feeding to conveyor will be uniform throughout the discharge time.

08.03 ELECTRICAL DETAILS

1.1 Microprocessor based Individual Weighing Controller (IWCs) with digital display and keyboards – for Belt weigh feeders/ Loss in weigh feeders

1.2 VFD drive for speed control of AC motors of belt weigh feeders with necessary switchgears, incoming choke, output reactors if required, protective devices, communication links with IWC, input/output for remote start/stop, interlocking, indication lamps, controls, metering, potential free contacts for remote status indication like ON/OFF/TRIP/ converter fault (to be wired to PLCs), motor protective devices at field etc. Technical features of VFD drive shall be as per General specification for electrical system(GS-03).
1.3 Individual Belt Weigh feeder panels housing IWC (Intelligent weighing controllers) controller & VFD drive, DOL starters for vibrating hoppers interlocked with belt weigh feeders.

1.4 Microprocessor based Bin weight measuring panels with digital display and keyboards with auto taring and auto calibration facility. Bin Measurement panels housing IWC controller (IWC Controllers for more than one Bin can be combined in one panel.

1.5 Belt weigh scale panels (if any as per Mechanical scope) housing microprocessor based measuring indicator with digital display and keyboards with auto taring and auto calibration facility.

1.6 Provisions for Communication with DCS/PLC

Belt Weight feeder IWC, Bin weigh measuring controller & Belt Weigh Scale IWC shall be able to communicate 100% with purchaser’s PLC/DCS on the plant communication bus as selected (like Profibus DP) by Tenderer.

1.7 Load cells, techogenerators, field junction boxes, limit switches etc. for Belt weigh feeders, Bin level measuring systems, Belt weigh scales (if any).

1.8 Common local control station for Belt weigh feeders & Vibrating hoppers (as applicable) housing Local /Off/Auto selector switches, Start/stop push buttons, speed increase/decrease, TPH indicators etc.

1.9 Local Indicator panels for Bin weighing control & Belt weigh scales (if any)

1.10 LT AC motors for belt weigh feeders & vibrating hoppers.

1.11 Calibration weights for belt weigh feeders.

1.12 Supply of dummy load cells for various Bunkers (BLMS system)

1.13 Features for Belt slip detection in case of weigh feeders, like tail end tacho or other suitable measures shall be provided by Tenderer.

2.1 DESIGN BASIS FOR BELT WEIGH FEEDER/LOSS IN WEIGH FEEDER

The consistency of the feed rate shall be guaranteed within +/- 0.5% of the set value within the operating range of 10% to 100% of rated capacity. The weighing control shall be totally automatic with close loop control. The feed rates of different materials shall be calculated by the computer and set points of Belt weigh feeder shall be set by the computer through PLC. In case of computer failure manual setting (remote manual) and operation of feeders shall be possible.

2.2 CONTROLLER PANELS OF BELT WEIGH FEEDERS/LOSS IN WEIGH FEEDER PANEL

The IWCs for control of Belt weigh feeders/ LIWs shall be microprocessor based having automatic weighing and calibration facilities. The system shall be complete with protection against overloading. Accuracy of Belt weigh feeders shall be +/-0.5% or better of preset feed rate.

It shall be possible to operate the Belt weigh feeders under the following modes:

- Local - Volumetric
- Local - Gravimetric
- Remote - Gravimetric (remote manual/PLC automatic)

Under remote mode of operation, following control shall be possible.
Remote - From IWC panel
Remote - From HMI station at BF control room.

Microprocessor shall be provided with each IWC as per standard design/system requirement. IWC shall generate signal for material feed rate in t/hours. The IWC shall compare the actual feed rate with the set point feed rate and generate a suitable correction for the VVVF converter of belt drive. The signal shall change the belt speed and accordingly provide the desired feed rate. It will be complete with auto calibration, auto tare, auto belt slip/drift monitoring facilities etc. The stored values after calibration shall not change due to power failure.

Belt Weigh feeder panel housing above IWC & VFD drive shall also be provided with following control equipment/facilities.

Main incoming MPCB/MCCB (50kA) for incoming power supply
Control transformer (415/110V) with MPCB (50kA) at primary, MCBs at secondary.
MPCB, Power contactor (min. 25A), thermal overload relay, necessary auxiliary contactors, ON/OFF/TRIP indication lamps for each motor of bin vibrating hoppers.
Necessary Power supply units, conversion equipment.
DP MCBs for incoming UPS power supply and its distribution to all panels.
Panel illumination lamps (fluorescent tubular).
Start/stop push button, selector switches as required.
Power ON indication.
Power and control terminals.

The IWC shall have following features (minimum)
Actual flow rate indicator.
Set rate feed indicator.
Totalised amount indicator.
Belt load indicator.
Belt speed indicator.
Deviation indicator.
Fault messages (separate lamps).
Operational mode selector switch for gravemetric/volumetric/calibration mode selection.
Auto taring & calibration.

Following displays and messages shall be possible for all the operating and calibrating functions:
Set point.
Normal/Maintenance/Calibration modes.
Actual feed rate.
Belt load (Platform load).
Belt speed.
Totaliser value.
Deviation error between set and actual feed rate.
Service data such as measured value, controller output, control signal level etc.
Event messages/fault messages.

The above shall be available on each IWC on digital display unit in central control room. Display and messages listed above shall also be made available on VDU of PLC/DCS.

Panel Construction features.
Floor mounted, free standing.
Dust and vermin proof.
CRCA sheet steel clad.
Minimum 2.0 mm thick for panels.
Suitable to withstand vibrations to be encountered in steel plant applications.
Cubicles with illumination lamps door switches, space heaters and adequate sockets for soldering. All control blocks plug-in-type with necessary test sockets. Units shall be self contained and serviceable. Power wiring-Min 2.5 sq.mm. Cu Control wiring – Min 1.5 sq.mm. Cu

The panel door shall be provided with toughened glass in front of controllers for viewing of display units without opening the panel door. All control devices and indicators shall be mounted on the front. Two numbers earthing studs shall be provided with the panel for external earthing. All power, control, and signal terminals of different voltages shall be segregated. 20% spare terminals shall be provided in the panel.

3.1 BIN/WEIGH HOPPER LOAD CELLS AND LEVEL MEASURING SYSTEM:

Design Basis for Bin Level Measuring System
Load cells shall be of high precision strain gauge type, hermetically sealed, robust in design, shock proof and insensitive to overload, temperature, vibration, electrical noise etc. Enclosure class shall be IP 67
Load cell shall be provided with ambient temperature compensating device upto 55 deg. C.

Provision shall be kept to neutralise the error caused due to application of transverse forces. Max. Measurement error permitted is +/- 1%

3.2 CONTROL PANEL FOR BIN LEVEL MEASUREMENT (BLM)HOUSING IWC

Bin level measurement system shall be microprocessor based having automatic weighing, taring and necessary calibration facilities. The system shall be complete with protection against overloading. Accuracy of weighing +/-0.1% or better.
The controller shall have digital display and keyboards, indication, alarm, annunciation etc. It will be complete with auto calibration, auto tare facilities etc. The stored values after calibration shall not change due to power failure.
The controller shall be complete with built in power supply unit, CPU, program memory, A/D & D/A converters, etc. The above will be of modular design using standard PCBs and connectors.
It should communicate actual weight/level, conditions for bin empty, level low, level high etc to Automation system.

4.1 BELT WEIGH SCALES

The IWPs for control of belt weigh scales shall be microprocessor based having automatic weighing and necessary calibration facilities. The system shall be complete with protection against overloading. Accuracy of belt weigh scale shall be +/-0.25% or better of flow rate. Microprocessor as per standard design/ system requirement shall be provided each IWC. Microprocessor shall multiply load cells and conveyor speed signal in digital form to generate signal for material conveying rate in T/Hours. It will be complete with auto calibration, auto tare etc. The stored values after calibration shall not change due to power failure.
The following displays and messages shall be available for all the operating and calibrating functions:
Conveying rate in TPH.
Belt load (Platform load)
Belt speed.
Totaliser value.
Service data such as measured value, controller output, control signal level etc.
Event messages/fault messages.
Auto taring & Error corrections.
The above shall be available on each IWC on digital display unit. Display and messages listed above will be made available on VDU of in central control room.

Panel Constructional feature
Shall be same as for Weigh feeder panels.

5.0 DIGITAL TECHGENERATORS

It will be of robust construction and designed to give guaranteed accuracy of feed rate. It shall generate consistent output pulses of positive or negative polarity as applicable by accepting shaft rotation. The output pulses shall be suitable for feeding into high impedance electronic circuit/instrument for digital measurement and control. The enclosure class shall be IP 67. It will be provided with ambient temperature compensating device.

Arrangement of mounting of techogenerators and its coupling with AC motor shall be decided considering ease of maintenance.

6.0 LOCAL CONTROL BOX (LCB) FOR BELT WEIGH FEEDERS/LOSS IN WEIGH FEEDER & LOCAL INDICATION BOXES FOR BLMS & BELT WEIGHERS.

Each belt Belt weigh feeder/Loss in weigh feeder shall be supplied with a local box with following features.
Sheet steel (2.0mm thick) construction.
Wall/structure mounted type.
Hinged door, dead front type.
Enclosure class IP-55.
To be painted as per standard procedure agreed.
Internal wiring with 1.5 sq.mm copper conductor.
The box shall be wall/structure mounted type and be complete with cable glands and lugs.
The LCB shall be provided with the following:
Local – Off – Remote selector switch.
Start/Stop push buttons
Emergency stop push button (press to lock turn to release type)
Increase/decrease PB for speed setting
Feed rate actual (TPH meter – digital type).
Start/stop push button for bin vibrator
Indication lamps.
Any other device required for satisfactory operation of BWFs to be decided during detailed engineering.
Each local indication box for BLMS/Weigh Scales shall have digital indication of Bunker level/feed rate.

7.0 LOAD CELLS

Compression type suitable for weigh hoppers and material presence detectors on BF charging conveyor.
Enclosure class IP 67
Strain gauge/pressductor type
300% over load capacity.
Suitable for maximum 70ºC.
Temperature compensation up to 50 deg C.
Capacity of the Load cell for BLMS system shall be as per details given under mechanical part. However, final rating of load cells shall have safety margin of minimum 150% of the rating calculated. Load cell accuracy 0.04%
Complete with excitation source, transmitter, amplifier, junction boxes, special cables, etc.
08.04 DOCUMENTATION

1. Drawings and documents to be submitted by the Tenderer with tender the Tenderer shall submit the following technical drawings & technical data/information along with tender for weigh hopper without which the tender shall be considered as incomplete & may not be considered for acceptance.

   a. Drawing showing general arrangement of the equipment, general description of design consideration and all the assumption made by the supplier.

   b. Detailed specification for the equipment offered & mounting/ accessories etc., together with descriptive literature/ catalogues etc.

   c. Details of load cell such as type, rating, make and other details

   d. Calculation substantiating selection of equipment.

   e. Specification of materials of construction of major parts/ components along with standards and chemical composition.

   f. Catalogues/leaflets for all equipment including bought-out items. Details of bought-out items with makes shall be given separately.

   g. G.A. drgs for the equipment/ system including sections and details giving relevant information, binding dimension.

   h. Standard/ special accessories being considered for supply along with the equipment.

   i. Requirement of tools and tackles for erection and maintenance.

   j. Requirement of utilities and services.

   k. The tenderer shall also duly complete the “Questionnaire” & submit along with the quotation without which the offer may not be considered.

2. List of drawing/documents to be furnished by the Successful Tenderer

   The following drawing/ document are to be submitted by the Successful Tenderer within one month of placement of order:

   a. General arrangement drawing of equipment showing full details of weigh hoppers in plan and section along with design calculations.

   b. Quality assurance plan for inspection

   c. Requirement of tools and tackles for erection.

   d. Part list, bill of materials and material specification.

   e. Major sub assembly drgs., details of liner plates, safety features etc.

   f. List of spares, special tools and tackles

   g. Operating and maintenance manuals.
3. **List of drawings/documents to be furnished alongwith equipment by the Successful Tenderer**
   
a) All approved GA drawings, complete assembly and sub assembly drawings of the equipment.
   
b) Drawing of all equipment/component received from sub suppliers.
   
c) Engineering and design calculations.
   
d) Test reports and inspection reports
   
e) Instruction manuals for testing and commissioning
   
f) Operation, maintenance and safety manuals in ten copies
   
g) Requirement of special tools and tackles, if any, for subsequent maintenance
   
h) Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions.
   
i) List of spare parts with drawings, sketches, specifications and manufacturer’s catalogues.
   
08.05 **QUESTIONNAIRE**

The Tenderer shall submit the following details along with the quotation of the equipment.

1. General arrangement drawing showing overall dimensions and mounting details of the hopper.
2. Capacity of weigh hoppers- effective and geometric
3. Material and liner of weigh hopper and thickness.
4. Details of feeding Chute to weigh hopper
5. Material & liner for Chute and thickness
6. Total weight of the equipment and weight of individual parts.
7. Weighing accuracy.
8. Weighing range.
10. Response time, repeatability
11. Taring time, repeatability.
12. Load cell
   
i. Make and type
   ii. Model No.
   iii. Quantity/ hopper
   iv. Measuring principle
   v. Enclosure class- IP 67
   vi. Rated capacity
   vii. Details of output signal.
   viii. Deflection related to rated cap.
   ix. Rated output signal to rated cap.
   x. Zero unbalance related to rated cap.
   xi. Maximum temperature.
   xii. Compensated temp. range.
xiii. Temp. effect on zero unbalance
xiv. Temp. effect on related output
xv. Over load capacity
   - Safe limit
   - Ultimate limit
xvi. Accuracy
xvii. Hysteresis
xviii. Linear error

13. Connecting cable
   - Type of cable
   - Size of cable
09  BELT WEIGH SCALE

09.01  Scope Of Work

The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of electronic micro-processor based Belt Weigh Scales as covered under this specification.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

- Two years maintenance spares.
- Commissioning spares as required during testing and commissioning of the equipment.
- Insurance spares.
- Required quantity of initial fill of oil, grease, lubricants, hydraulic fluid etc. and other consumables which are necessary for cleaning/flushing including erection, testing and commissioning the equipment shall be in the scope of supply of the Tenderer.
- Necessary tools and tackles for each equipment required for maintenance, testing or inspection of the equipment.

09.02  TECHNICAL SPECIFICATION

1. General

Belt weigh scale for measurement of flow rate and total-quantity shall be provided at specified locations as per relevant requirement as indicated in data sheets. System shall be complete with flow rate indicator, totaliser, control panel etc.

2. Codes & Standards

The design, manufacture, inspection and testing of Belt Scales shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Belt Scales shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted.

IS:11547  Electronic weighing in motion system
3. **Equipment Specification**

The weigh scale shall be automatic and electronic type. It should be designed for continuous automatic weighing, metering of coal flow.

Each belt weigh scale shall comprise of a belt weigh scale platform with minimum 4 nos. weighing idlers. It shall have unitised construction for ease of installation and shall be fully floating type (without pivot points). Minimum 3 nos. hermetically sealed load cells of precision strain gauge type shall be applied in tension to support the weigh bridge. The load cells shall have 100% overload protection and shall be structurally safe upto to 250% of rated belt scale capacity.

Belt scale shall be electronic microprocessor based with its program stored in non-volatile memory.

It shall be provided with self diagnostic features for trouble shooting of the entire belt scale system.

Fully automatic zero and span calibration facility shall be provided. The electronic systems offered by the Bidder shall include all signal conditioning, power amplifiers and printed circuits etc. The printed circuits shall be encapsulated against dust and moisture.

Belt scale shall be provided with flow rate total quantity etc. Remote flow rate indicators shall also be provided in the Central Control Room (CCR).

The flow rate indicator shall have minimum 4 digits. The flow totalizer should have 8 digits display scale with reset facility.

Complete belt scale system shall be suitable for 50°C ambient temperature and 100% relative humidity. It shall be suitable for out door installation in a dusty area. The electronic circuit enclosure, sensors housing shall be dust and watertight. The electronic printed circuits shall be encapsulated with epoxy or other suitable material for protection against dust and moisture.

Minimum three years battery back up power failure protection shall be provided.

Belt scale shall be designed for a range of 20% to 120% of rated capacity with an accuracy of at least ±0.5% throughout its range.

Supply of test weights for calibration of belt scales shall be the tenderer's responsibility.

Local panel for belt scale shall be of sheet metal

Other Electrical details shall be as given under cl.no. 08.03 :Electrical Details

09.03 **DOCUMENTATION**

1. **List of drawings /data to be submitted along with tender**

a. General arrangement drawing with bill of material of equipment showing overall dimensions.

b. Supplier’s name for components & catalogues for these items shall be furnished.

c. List of commissioning spares proposed by the Tenderer.
d. List of recommended spares for two years maintenance of plant and equipment.

e. List of tools and tackles to be supplied with the plant and equipment.

f. Duly filled up questionnaire.

2. **List of drawing/documents to be furnished by the Successful Tenderer**

   The following drawing/document are to be submitted by the Successful Tenderer within one month of placement of order:

   a. General arrangement drawing of equipment showing full details of BWS.

   b. Quality assurance plan for inspection

   c. Requirement of tools and tackles for erection.

   d. Part list, bill of materials and material specification.

   e. Major sub assembly drgs., safety features etc.

   f. List of spares, special tools and tackles

   g. Operating and maintenance manuals.

3. **List of drawings/documents to be furnished alongwith equipment by the Successful Tenderer**

   a) All approved GA drawings, complete assembly and sub assembly drawings of the equipment.

   b) Drawing of all equipment/component received from sub suppliers.

   c) Engineering and design calculations.

   d) Test reports and inspection reports

   e) Instruction manuals for testing and commissioning

   f) Operation, maintenance and safety manuals in ten copies

   g) Requirement of special tools and tackles, if any, for subsequent maintenance

   h) Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions.

   i) List of spare parts with drawings, sketches, specifications and manufacturer's catalogues.

**09.04 Questionnaire**

Type : 

Operation : 

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Material Handling and Hoisting
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10 VIBRATION ISOLATION SYSTEM

10.01 Scope

- This specification broadly covers design, engineering, supply and erection of vibration isolation system for crushers and other such equipment.

- Scope shall include all steel helical spring units and viscous dampers, including associated auxiliaries for installation of the spring unit dampers like steel shims, adhesive pads etc.

- All frame(s) pre-stressing of spring elements.

- Static and dynamic analysis of the vibration isolation system with the RCC top deck and the crusher shall also be included.

10.02 Codes and Standards

For the design of crusher foundations, the latest revisions of following codes shall also be referred:


(ii) IS: 2974 (Part-IV) -1979 code of practice for design and construction of machine foundations - Foundation for rotary type machines of low frequency.

(iii) IS: 1893-1991 (Criteria for earthquake resistant design of structures).


10.03 Technical Specification

- Detailed dynamic analysis shall be done for the top deck together with springs and dampers and natural frequencies & amplitudes of vibration shall be determined. A mathematical model of top deck shall be formulated with three-dimensional beam / plate finite elements for the purpose of analysis with the springs idealized with vertical and horizontal stiffness. The mass of the machine together with the top deck shall be considered for analysis.

- Natural frequency upto at least 10% above the operating frequency shall be determined and these frequencies shall be checked against the design criteria. Forced response dynamic analysis shall be carried out for the operating condition, unbalance forces using a sinusoidal forcing function. Unbalance forces as applicable for the crusher, shall be used for the purpose. The dynamic forces from the analysis shall be used for structural design with suitable fatigue factor.

- The vibration isolation system shall be designed for at least 90% isolation efficiency.

- Spring system being supplied shall be of such stiffness that a ratio of at least 10 (ten) should be possible to be adopted for the stiffness of supporting structure with respect to the stiffness of the spring system in each direction to achieve decoupling between the two (The stiffness of spring system being lower).
• The foundation system shall be designed such that a frequency ratio (ratio of operating frequency to the fundamental natural frequency) of at least 3.5 is achieved. In addition, the first bending frequency of the RCC deck shall be 20% above the operating frequency.

• The calculated amplitudes shall not exceed following limits under the specified conditions.
  a) 150 microns for an unbalance force arising out of balance quality grade G-40 as per ISO: 1940-1986.
  b) 250 microns in case of one millimetre eccentricity in the rotor.
  c) 250 micron mean-to-peak for unbalance in case of one hammer broken condition.
  d) Amplitudes need not be checked for three hammers broken condition. It is sufficient to check static strength under this condition.

• The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitudes shall be calculated at critical points on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitudes occurring in different directions due to the rotating vector may be considered while superimposing the modes.

• Transient resonance, which may occur during the start-up or coasting down condition of the crushe, shall be checked and the amplitudes in such a condition should not exceed one-and-half times those at operating speed for each design condition.

• The following criteria shall apply for the design of the top deck:
  a) Dead loads, live loads, seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall be considered for design.
  b) Seismic loads shall be assumed to act together with dynamic loads for a one-millimetre eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together.
  c) Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.
  d) Working stress method shall be used for the design of RCC deck. In survival condition, 10% overstressing may be permitted.
  e) The RCC top deck shall be of M-25 grade of concrete as per IS: 456:1978.
  f) Fatigue need not be considered for the three hammers broken condition.
  g) For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered.

The vibration isolation system, all accessories and the supporting structure shall be designed to withstand seismic loading in addition to dead loads, live loads and dynamic loads. The seismic co-efficient shall be taken as per the zone defined by IS: 1893-1991 criteria for earthquake resistant design.

10.04 DOCUMENTATION

1. List of drawings/data to be submitted along with tender

   a) General arrangement & Sections drawing of vibration isolation system showing overall dimension and details.

   b) Name of supplier.
c) Duly filled up questionnaire.

2. **List of drawings to be submitted for approval by successful tenderer**

   Drawings listed hereinafter shall be submitted to the Purchaser/ MECON for approval, starting within one month of issue of letter of intent and prior to the commencement of fabrication.

   a) General arrangement drawing of the vibration isolation system showing overall dimension and details including bill of material etc.

   b) Static and dynamic analysis of the vibration isolation system with the RCC top deck and the crusher shall also be included.

   c) All calculations.

   d) In addition to the above, the Purchaser/ Consultant reserve the right to insist on submission of calculations/ for component selection.

3. **Drawing/data/calculation for reference to be submitted by successful tenderer**

   a) General arrangement drawing of the vibration isolation system showing overall dimension and details including bill of material etc.

   b) Static and dynamic analysis of the vibration isolation system with the RCC top deck and the crusher shall also be included.

   c) All calculations.

   d) Procedure for testing and commissioning.

   e) Catalogues/literatures

   f) Operation and maintenance manual.

10.05 **Questionnaire**

   The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

   01. Name and address of the Tenderer :

   02. Previous experience of the Tenderer :

   03. List of similar equipment supplied along with user’s certificate :

   04. Location / Nos. off

   05. Equipment for which intended :

   06. Material of construction of different parts:

   07. Building in which the VIS is located :

   08. Total weight and weight of individuals parts:
11 TRAVELLING TRIPPERS AND BUNKER SEALING ARRANGEMENT

11.01 Scope

1. The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of Travelling /Trippers & Bunker Sealing Arrangement, as covered under this specification.

2. The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

3. The scope of supply and services of the Tenderer shall include the following:

   a) Mechanical
      - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, structural, mechanical and other standard accessories.
      - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment and feed chute.

   b) Electricals and controls

4. Two years maintenance spares.

5. Commissioning spares as required during testing and commissioning.

6. Insurance spares.

7. Required quantity of initial fill of oil, grease, lubricants, hydraulic fluid etc. and other consumables which are necessary for cleaning/flushing including erection, testing and commissioning the equipment shall be in the scope of supply of the Tenderer.

8. Necessary tools and tackles for each equipment required for maintenance, testing or inspection of the equipment.

9. Statutory approval wherever required shall be taken by the Tenderer for the equipment being supplied by them from relevant state/central authorities.

10. The scope of work shall stand supplemented by such details as are given in this specification, tender drawing, and instruction to the Tenderer, General Conditions of Contract (GCC), or any other part of the document.
11.02 Technical Specification

1. The tripper shall be designed as per IS: 14386-1996.

2. Travel drive of trippers shall be individual wheel drive, independent of the main conveyor drive and shall be through electric motor, helical gear box etc. Chain drive shall not be used. Tripper shall be provided with D.C. electro-magnetic brake for stopping the same at desired location. Travel speed of trippers shall not exceed 0.2 m/sec.

3. The traveling tripper shall consist of belt scraper with adjustable rubber strip, rubber lagged head and bend pulleys complete with shaft bearings, chutes, stops and limit switches, brakes etc. The tripper shall have two-way discharge chute which shall be capable of discharging material into the bunker openings.

4. Traveling trippers shall be of adequate length with proper slope of conveyor idlers to match with the flow properties of material being handled. The maximum inclination of the conveyor belt on the tripper shall not be more than 12°.

5. Vertical and horizontal guide rollers shall be provided to control sway and uplift of the belt in unloaded condition. The tripper shall run on standard flat bottom Indian Rails at least of 60 lb/yd. Wheels shall be double flanged with parallel tread running on anti-friction bearings and shall have min hardness of 350 BHN. Material of wheel shall be forced steel / cast steel.

6. Traveling trippers shall be equipped with manually operated rail clamps and rail cleaners and jacking pads.

7. Diverter gates on two way or three way chutes shall be electrically operated.

8. Power supply to the tripper shall be given through motorized cable reeling drum with trailing cables, cable trays for resting the trailing cables and end limit switches for protection against over travel of the tripper. The cable reeling drum and trailing cable of each tripper shall be suitable for the entire length of the bunker bay. The cables shall have copper conductors, proper insulating material and braided armoring in accordance with IS: 691.

9. Position indicators shall be provided as per requirement of control logic. Operating push buttons for local control and emergency stop shall be within easy reach of the operator on the main conveyor walk way.

10. All stipulation regarding belt pulley, belt scraper, idlers, safety guards, wind guard, access for maintenance etc. specified for belt conveyors, diverter gates and discharge chutes shall be applicable for the traveling tripper.

11. The rating of tripper travel motor shall be adequate to move the tripper smoothly either in forward or opposite direction to belt direction under fully loaded conditions. Coefficient of friction shall be taken as maximum 0.15.

12. Minimum two drive axles shall be provided for tripper travel. Arrangement shall be provided at the starting point of the tripper to avoid folding of belt.

13. Provision shall be kept for automatic tripping of bunker bay conveyor in event of traveling tripper getting dragged (i.e. travel speed in excess of rated speed).
14. The supporting structures for the rails with necessary end stops shall also be supplied under this specification. Suitable belt hold down guide pulley shall be provided over the concave curve of belt over tripper.

15. The bunker sealing arrangement shall keep the bunkers sealed and prevent dust emission into tripper room.

16. Separate openings shall be provided on the bunker floor of each bunker to measure level of material in the bunker. Hinged door/ flaps shall be provided on these openings.

17. Suitable gratings are to be provided in between bunkers in the tripper travel zone. Opening size shall be decided during the detail engineering stage.

18. Suitable dust cover shall be provided over tripper head pulley. Serrated rubber seal shall be provided at open side to prevent dust nuisance. Suitable dust tight access doors shall be provided. Counter weighted type belt cleaner shall be provided below the tripper head pulley to cleaning the carrying side of the belt.

19. Suitable access platform of Chequered plate with ladders, hand railings and walkways on both sides shall be provided for access / maintenance of equipment on tripper. Also crossover platform shall be provided with tripper so that operator can cross the belt through the same.

20. Continuous deck plates shall be provided below carrying idlers on the trippers.

11.03 DOCUMENTATION

1. Drawings / document to be supplied by the Tenderer

   a) General arrangement drawing of Mobile Tripper showing overall dimension, profile, idler spacing, LT drive arrangement, motor kW etc. along with chutes, scrapper, skirt boards, switches, wheel load, wheel spacing, wheel diameters, power supply arrangement for travel drive etc.

   b) Details of bought-out items & component list.

   c) List of commissioning spares proposed by the Tenderer.

   d) List of recommended spares for two years maintenance of the equipment.

   e) Duly filled up questionnaire given below.
2. **Drawings / documents to be supplied by the successful bidder for approval.**

   a) **For approval.**

      General arrangement drawing showing the following:
      
      i. Constructional feature.
      
      ii. All dimensions and technical parameters as per technical specification.
      
      iii. LT drive & their arrangement
      
      iv. Motor ratings.
      
      v. Speeds.
      
      vi. Maintenance and repair provision.
      
      vii. Operating weight.
      
      viii. Any other information for making the GA drawing complete.

   b) **For reference / records.**

      i. Major sub-assembly drawings of drives, safety features, lubrication arrangement etc.
      
      ii. List of spares, consumables, special tools & tackles.
      
      iii. Operation & maintenance manuals.

11.04 **Questionnaire (To be filled by by Tenderer)**

1. The Tenderer shall also furnish the following questionnaire and submit with his offer. This data shall form a part of the contract with Successful Tenderer.

**General**

01 Name and address of the Tenderer : 

02 Previous experience of the Tenderer : 

03 List of similar equipment supplied : 

04 Tripper Details

05 Sealing belt details : 

06 List of drgs./ literatures enclosed with the offer. :

07 Drive details
08  Motors
   a) KW rating :
   b) RPM :
      a) Type :
      b) Bearing
         Make :
         Expected life (hrs) :

09  Gear Box
   a) Make :
   b) Type :
   c) Reduction ratio :
   d) Torque rating (kg-m) :
   e) Overall efficiency :
   f) Wt. of Gear box (kg) :

10) Couplings
   a) Make and type of high speed couplings :
   b) Make and type of low speed couplings :
   c) Weight (kg) :

11) Belt cleaners – type :
    – Weight (kg) :
12 IN LINE MAGNETIC SEPARATOR (ILMS)

12.01 Scope Of Work

- The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics and standard accessories of In-Line Magnetic Separator as covered under this part of the specification.

- The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

- The scope of supply and services of the Tenderer shall include the following:
  
  a) Mechanical
     - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, structural, mechanical and other standard accessories.
     - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment.

  b) Electricals
     - All fixing bolts and nuts including foundation bolts shall be included in the scope of supply of Tenderer.

     - Two years maintenance spares.

     - Commissioning spares as required during testing and commissioning of the equipment.

     - Insurance spares.

     - Required quantity of initial fill of oil, grease, lubricants, hydraulic fluid etc. and other consumables which are necessary for cleaning/flushing including erection, testing and commissioning the equipment shall be in the scope of supply of the Tenderer.

     - Necessary tools and tackles for each equipment required for maintenance, testing or inspection of the equipment.

     - Statutory approval wherever required shall be taken by the Tenderer for the equipment being supplied by them from relevant state/central authorities.

     - The scope of work shall stand supplemented by such details as are given in this specification, tender drawing, and instruction to the Tenderer, General Conditions of Contract (GCC), or any other part of the document.
12.02 TECHNICAL SPECIFICATION

• General

Inline Magnetic Separators shall be provided for continuous and automatic extraction and discharge of tramp magnetic pieces from coal being discharged from conveyors as specified. The sets shall be complete in all respects with motor, drives, magnets, in line belts, hoppers, chutes, tramp-iron boxes and all electrical ancillaries like control panels etc. Inline Suspended Magnetic Separator (ILMS) shall be provided for picking up tramp magnetic pieces buried under coal from moving coal over Conveyor as specified.

• Codes & Standards

The design, manufacture, inspection and testing of In line Magnetic Separators shall comply with all the currently applicable statutes, regulations and safety codes in The Magnetic Separators shall conform to the latest edition of standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility.

• Equipment Specification

Magnet core material shall be pure annealed iron or equivalent high permeability magnetic material. The coil shall be of aluminum wire with class ‘H’ insulation, to limit the absolute temperature of the winding to 140 deg. centigrade. The ILMS shall be silicon oil cooled.

The ‘Force Index’ i.e. the product of flux density in gauss and rate of change of flux density w.r.t. distance, at the bottom of falling material trajectory shall be 100,000 (gauss x gauss/inch) minimum in hot condition for mounting height of 400 mm. However, the strength of the magnet shall not be less than 1000 gauss in hot running condition at 400 mm distance. The minimum strength of the magnet shall be 1000 gauss at the specified mounting height at the centre of Belt width. Bidder shall to select magnet width to suit above.

Mounting height of 400 mm shall be taken between top of conveyor belt or bottom of falling material trajectory and the surface of magnetic separator belt. Characteristic curve of magnet with the value of flux density varying between 50 mm to face of conveyor belt shall be provided. The cross section of magnet shall be suitably designed to provide sufficient area for magnetising the coil effectively covering full cross section of the discharge material. The magnetic separator shall be located such that it picks-up tramp iron from coal trajectory after it has been discharged from head pulley.

The tramp magnetic pieces buried under coal picked up by the magnetic separator shall be discharged suitably to ensure that it falls into the tramp iron chute, which shall be provided upto ground level. All conveyors with magnetic separator at head end shall have non-magnetic SS pulleys and shafts.

The motor and the gear reduction unit for driving the in-line belt shall be adequate sized with minimum 20% margin to avoid any over loading during operation. Suitable zero speed switch shall be provided. No Chain/belt drives shall be accepted.

The belt shall be designed to withstand high temperature at the bottom of the magnet and any serious damage due to the impact of the sharp edges of the tramp iron. The belt shall be provided with rubber cleats spaced suitably. The belt shall be of fire resistant grade. Side rollers shall be provided to keep the belt aligned.
The idlers and the pulleys supporting the belt shall be manufactured to the best engineering practices and shall conform to relevant Indian Standards.

Material to be separated as tramp iron by ILMS:

- The maximum weight of 50 Kg having ‘L/D’ > 5 of iron or steel piece of any shape (except sphere) below the material heap of 250 mm.
- MS round bar with ‘L/D’ ≥ 5
- MS Bolt ‘L’ = 5 X Diameter.
- MS Nuts with Diameter ‘L/D’ ≥ 10 mm

• Construction Requirement

The magnetic separator units shall be supported by suitable structural member from the top by taking support from the operating floor beams with turn buckle arrangement to facilitate the necessary adjustments during operation.

ON/OFF control push buttons with indicating lamps shall be provided at the local station. The materials of chutes and hoppers associated below the ILMS shall be SS-304 in the magnetic zone. Other chutes shall be made of MS.

Suitable arrangements shall be provided in the magnet for keeping the coil of the magnet dry from atmospheric condensation when the magnetic separator is not in use.

12.03 Documentation

1. List of drawings/data to be submitted along with tender

a) General arrangement drawing with bill of material of equipment showing overall dimension, motor kW (if any), drive arrangement etc. details of limit switches along with load data, weight etc.

b) Supplier’s name for components (like motors, coupling, gearbox etc.) catalogues for these items shall be furnished.

c) List of commissioning spares proposed by the Tenderer.

d) List of recommended spares for two years maintenance of plant and equipment along with itemised price.

e) List of tools and tackles to be supplied with the plant and equipment.

f) Duly filled up questionnaire given

2. List of drawings/data to be submitted by successful tenderer

a) General arrangement drawing with bill of material of equipment showing overall dimension, motor kW (if any), drive arrangement etc. details of limit switches along with load data, weight etc.
b) Supplier's name for components (like motors, coupling, gearbox etc.) catalogues for these items shall be furnished.

c) List of commissioning spares proposed by the Tenderer.

d) List of recommended spares for two years maintenance of plant and equipment along with itemised price.

e) List of tools and tackles to be supplied with the plant and equipment.

12.04 QUESTIONNAIRE

Type : 
Suspension device : 
Location of ILMS : 
Force index (As defined earlier) : 
Strength of magnet at the specified mounting height : 
Mounting height : 
Weight of total assembly : 
Magnetic Separator belt :
  (i) Drive Unit 
  (ii) Belting 
  (iii) Discharge 

Tramp Iron Items
  (i) MS cube of 20 mm size 
  (ii) Brake shoe of Railway Wagon (Cast Iron 15 Kg.) 
  (iii) MS plate of 250 x 250 x 100 mm size. 
  (iv) Shovel Teeth and spikes. 
  (v) MS round bar of 50 kg with L/D ratio not exceeding 5 

Control
Magnetic Cooling system
Location of silicon rectifier unit
13 METAL DETECTOR

13.01 Scope Of Work

The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all electrics / electronics / microprocessors and standard accessories of Metal Detector as covered under this specification.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

- The scope of supply and services of the Tenderer shall include the following:
  a) Mechanical
     - Each equipment shall be complete in all respect including, its drive units, cables, safety switches, structural, mechanical and other standard accessories.
     - Provision of necessary fixtures, supporting angles and brackets required for mounting and supporting the equipment.
     - The Tenderer shall also include supervision services at site during erection, testing and commissioning of the equipment supplied by them.
  b) Electricals
     - All fixing bolts and nuts including foundation bolts shall be included in the scope of supply of Tenderer.
     - Two years maintenance spares..
     - Commissioning spares as required during testing and commissioning of the equipment.
     - Insurance spares.
     - Required quantity of initial fill of oil, grease, lubricants, hydraulic fluid etc. and other consumables which are necessary for cleaning/ flushing including erection, testing and commissioning the equipment shall be in the scope of supply of the Tenderer.
     - Necessary tools and tackles for each equipment required for maintenance, testing or inspection of the equipment. The list of such tools and tackles shall be furnished and included in offer.
     - Statutory approval wherever required shall be taken by the Tenderer for the equipment being supplied by them from relevant state/ central authorities.
     - The scope of work shall stand supplemented by such details as are given in this specification, tender drawing, and instruction to the Tenderer, General Conditions of Contract (GCC), General Technical Specification (GTS) or any other part of the document.
13.02 TECHNICAL SPECIFICATION

- Codes & Standards

The design, manufacture, inspection and testing of Metal Detectors shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The Metal Detectors shall conform to the latest edition of standards/codes, which ensure equal or higher performance than those specified, shall also be accepted. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility.

- Equipment Specification

Metal detectors shall have high reliability with enough sensitivity to detect 25 mm aluminium sphere below the burden of material. It shall also detect other metals like brass, copper, stainless steel, manganese steel, bars, scraps etc.

The equipment shall have provision for automatic static calibration with adjustable sensitivity.

Metal detectors shall be completely solid state using latest state of art technology. It shall be suitable for 50°C ambient and RH of 100%. The search sensor shall be protected from rain and direct sunlight by means of a non metallic covering other than wood. Control unit shall have adjustable controls for sensitivity, ON/OFF push buttons, reset table operation counter, audio-visual alarms local remote selector switch and all other necessary controls for trouble free operation of metal detector. It shall be suitable for mounting on wall, column, structure, etc. with IP-65 degree of protection. It shall be constructed from FRP of thickness not less than 2 mm.

The metal detectors shall also have the following features:

- The coils shall be protected against being struck by an oversized material/coal.
- In order to counteract interference from external sources such as motors, lighting and radio-transmitters, and to nullify the effect of climate changes/aging, dual receiver coils are to be used.
- In order to allow passing of metal belt fasteners without giving alarm and at the same time detection tramps, suitable arrangements shall be provided.
- In case a few non-magnetic idlers or non magnetic deck plates are required, the bidder shall provide these. However, these shall be metallic. Wood is not be used.
- LED display of COAST COUNT to indicate the number of pieces of tramp iron detected since last reset shall be provided so that the operator is alerted for the pieces of tramps, if any, between tramp marker and coil before restoring conveyor.
- TOTAL COUNT, which is not resettable, shall also be provided on the same LED display on demand.
- The location of tramp metal pieces shall be indicated by liquid colour spray.

Construction Requirement

- Fiber glass enclosure (with IP-65 degree of protection) shall be provided for all type of coils.
Suitable tramp metal markers shall be provided.

Local control panel shall be provided with IP-65 degree of protection.

13.03 Documentation

1. List of drawings /data to be submitted along with tender
   a) General arrangement drawing with bill of material of equipment showing overall dimension and details.
   b) Supplier's name for components & catalogues for these items.
   c) List of commissioning spares proposed by the Tenderer.
   d) List of recommended spares for two years maintenance of plant and equipment.
   e) List of tools and tackles to be supplied with the plant and equipment.
   f) Duly filled up questionnaire.
   g) The Tenderer has to furnish one copy of the specification drawing duly signed by him as a token of acceptance along with the list of deviation from tender documents.

2. List of drawings /data to be submitted by the successful tender
   f) General arrangement drawing with bill of material of equipment showing overall dimension & details.
   g) Supplier's name for components & catalogues for these items shall be furnished.
   h) List of commissioning spares proposed by the Tenderer.
   i) List of recommended spares for two years maintenance of plant and equipment along with itemised price.
   j) List of tools and tackles to be supplied with the plant and equipment.

13.04 Questionnaire

Type & Name of Supplier
Sensitivity
Enclosure
Control
Calibration
Tramp metal markers
14  CHARGING HATCH

14.01  SCOPE OF WORK

The scope of work of the Tenderer shall include design, engineering, manufacture, fabrication, assembly, testing and inspection, packing, dispatch, transportation, delivery FOR Purchaser’s site, unloading, handling and storage at site, insurance during storage, erection supervision, testing, inspection, commissioning, guarantee testing and handing over to the client including all standard accessories of Charging Hatches.

The scope of the Tenderer shall be deemed to include all such items which although are not specifically mentioned in the specification, but are needed to make the equipment complete in all respect for its safe, reliable, efficient and trouble free operation.

- The scope of the Tenderer shall also cover inclusion of necessary fixtures, supporting angles and brackets required for mounting the charging hatches.
- Necessary sealing work required for arresting the dust shall also be under the scope of the Tenderer.
- The scope of work shall stand supplemented by such details as are given in this specification and instruction to the Tenderer, General Conditions of Contract (GCC), or any other part of the document.

14.02  TECHNICAL SPECIFICATION

Charging hatches are meant for hermetically dust sealing of bunkers during feeding of materials by feeding conveyors.

- The working principle of charging hatches shall be as follows:

  Raw materials after being discharged from conveyor shall fall into the respective bunkers through charging hatches. When material is discharged at any section of the inclined removable slide plate by a shuttle belt conveyor, the pressure generated by the falling material shall be able to push the respective curtain plates to make the required opening for being fed to bunker.

  The flaps of charging hatch, normally closed, shall open under dead weight of material and close of its own under gravity after the materials falls into bunker. Thus the dust emitted by falling material is hermetically sealed.

  The charging hatch assembly shall rest on the Insert Plates provided in the respective bunkers.

  The plate used shall be of Mild Steel construction and minimum 10 mm thick. Diameter of the cross rods shall be minimum 32 mm.

  There shall be only one uniform size of charging hatches for all the bunkers.
14.03 DOCUMENTATION

1. Drawing and documents to be submitted with tender

The Tenderer shall submit following technical drawings & technical data/ information with tender for charging hatches without which the tender shall be considered as incomplete & may not be considered for acceptance.

a) General description of design consideration and all the assumption made by the supplier.

b) Typical GA drgs for the equipment/ system including sections and details giving relevant information, binding dimension etc.

c) Standard/ special accessories being considered for supply along with the equipment

d) The questionnaire filled in

2. List of drawing/documents to be furnished by the Successful Tenderer

h. General arrangement drawing of equipment showing full details of charging hatches in plan and section along with design calculations.

i. Quality assurance plan for inspection

3. List of drawings/ documents to be furnished alongwith equipment by the Successful Tenderer

1. All approved GA drawings, complete assembly and sub assembly drawings of the equipment.

2. Drawing of all equipment/ component received from sub supplier.

3. Engineering and design calculations.

4. Test and warranty certificate for each item of equipment.

5. Test reports and inspection reports.

6. Instruction manuals for testing and commissioning.

7. Operation, maintenance and safety manuals.
14.04 QUESTIONNAIRE

1. Make

2. Nos of charging hatches offered / length of each hatch :

3. Gross weight of each charging hatch :

4. Material of construction of charging hatch plate

5. Liner materials used, type, thickness, fixing arrangement

6. Any other information as the Tenderer thinks necessary for installation, operation and maintenance of equipment
15 CRANES AND HOIST

15-A FOUR/DouBLe GIRDER EOT CRANE

15-A.01 The scope of work covers design, manufacture, fabrication/assembly, shop testing, painting, supply, storage, erection, testing & commissioning of cranes complete with electricals and standard accessories with attachments to be installed as covered in data sheets in Technical Specifications. Relevant codes and practices for the cranes shall be used for SAIL units relevant IPSS shall be used unless otherwise stated.

- All the equipment shall be of reputed make and proven quality with regard to their performance. The make shall be as per approved list of Purchaser/Consultant.

- The crane shall be inspected and tested during different stages of its manufacture (starting from raw materials till the completion of the crane) by the Purchaser/ his authorized representative at the Supplier's or his sub-supplier's works as per the inspection procedure mutually agreed between the Purchaser or his authorized representative and the Supplier. Inspection shall be regarded as a check up and shall be in no way binding on the Purchaser.

15-A.02 TECHNICAL SPECIFICATION

01 General

i) EOT cranes shall be designed, manufactured and tested in accordance with the latest revision of IS: 807-1976, 3177-1999, 4137 and IPSS.

ii) The crane components shall be standardized to keep the number of spares to the minimum.

iii) All parts requiring replacement or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structures. All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and maintained and when necessary any damaged cable can be accessed and replaced individually.

iv) All components for cranes of identical capacity and duty shall be interchangeable. Cranes of the same capacity and duty shall be identical in all respect unless otherwise required.

v) No cast iron parts shall be used except for electrical equipment and no wood or other combustible material shall be used unless specifically mentioned otherwise. Deviations, if any, to this clause shall be permitted only with the specific approval of the Purchaser.

vi) All machinery or equipment included under this specification must be equipped with safety devices and clearances to comply with recognized standards and Purchaser's requirements along with safety codes and statutes prevalent at the place of installation of the equipment.

vii) For welded construction such as that of bridge girders, end-carriages, rope drums, gear-boxes etc. steel shall be as per IS: 2062-1992 quality. For welding these members low hydrogen electrodes shall be used.

viii) All wheels, couplings, open gears etc. shall be provided with covers, opening on strong hinges. All heavy covers shall be provided with inspection windows.

ix) Where down shop leads are located below runway rails, guards shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads.
x) All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washers.

xi) For outdoor cranes all electrical and mechanical equipment which are exposed to weather shall be completely covered or made weather proof. The covers shall be segmental to facilitate easy dismantling and assembly.

xii) The end-carriages shall be fitted with substantial safety stops to prevent the crane from falling more than 25 mm in the event of breakage of a track wheel, bogie or axle. These stops shall not interfere with the removal of wheels.

xiii) Fasteners for pedestal blocks, motors, gear-boxes etc. shall be easily removable from the top. Studs or body bound bolts shall not be used as fasteners for mechanical items except for fixing cover.

xiv) Power & control cables shall be clamped in-groups separately. All trailing cables shall be clamped with PVC or non-metallic clamps. Group de-rating factor shall be appropriately taken according to the recommendations of the cable manufacturers based on the method of laying and number of cables being laid together.

xv) Guards of approved design, which will push forward off the track, any object placed across it, shall be attached to each end of the end carriages.

xvi) Parts of steel frames carrying machinery shall be provided with doubling plates of adequate thickness, riveted or welded and machined to true surface.

xvii) Defects in the material like fractures, cracks, blow holes, lamination, pitting etc. are not allowed. Rectification of any such flaw is permissible only with the approval of the Purchaser.

### 02 Tolerances:

The Tenderer / Supplier shall ensure that the crane shall be manufactured as per the tolerances specified below:

| (i) | Span over LT wheels | : | ± 6 mm upto 40 metres |
| (ii) | Wheel base | : | ± 5 mm |
| | LT | : | ± 3 mm |
| | CT | : | ± 5 mm |
| (iii) | Difference in diagonal | : | ± 5 mm |
| | LT | : | ± 3 mm |
| | CT | : | ± 1 mm |
| (iv) | Long travel wheel alignment | : | ± 1 mm/1000 mm |
| (v) | Tilt of wheels or balancer axle | : | (Horizontal & Vertical) |
| (vi) | Trolley wheel gauge | : | ± 3 mm upto 7500 mm span |
| | : | ± 5 mm above 7500 mm span |
| (vii) | Trolley track gauge | : | ± 3 mm upto 7500 mm span |
| | : | ± 5 mm above 7500 mm span |
| (viii) | Difference in height between trolley rails (H) in relation to the trolley track gauge (S) shall be within the following tolerances: | `S` (mm) | `H` (mm) |
Upto 2500 : 4
Above 2500 and upto 4500 : 6
Above 4500 : 10

(ix) Horizontal bend of girder in plan : Span / 2000

(x) Shift of the web plates of main & end girders from vertical over height 'H' measured near the mid span & close to the main diaphragm : H / 200

(xi) Twist of the main girder : Span / 1500

(xii) Axis of the flange plates from the axis of the beam : H / 250

(xiii) Tolerances on camber
- Upto 4 mm : (+) 4 (-) 0
- Above 4 mm and upto 8 mm. : (+) 5 (-) 0
- Above 8 mm and upto 16 mm. : (+) 6.3 (-) 0
- Above 16 mm and upto 31.5 mm : (+) 8 (-) 0
- Above 31.5 mm and upto 63 mm : (+) 10 (-) 0

(xiv) Over buffer length : ± 5 mm
(Over buffer dimension on two sides shall be same)

(xiv) Height of center of buffer (from top of track rail) : ± 5 mm
03 The crane after erection shall be tested as follows:

i) Insulation tests and other tests mentioned in IS: 3177-1999 shall be carried out.

ii) Deflection Test: The deflection test of the bridge girders shall be carried out as per IS: 3177-1999. After the deflection test with safe working load, the crane shall be tested for deflection with 25% overload and there shall not be any permanent set after the removal of the load.

iii) Speed Tests:
   a) All motion of the crane shall be tested with rated load on all notches at the time of commissioning of the crane at site and the speeds shall be attained within the tolerance limit.
   b) All motions of the crane shall be tested with 25% over load in which case the specified speeds need not be attained but the crane shall show itself capable of dealing with the overload without difficulty.

iv) Brake Tests:
   a) The hoist brakes shall be capable of braking the movement with rated as well as overload. However, the braking path with rated load shall not exceed hoisting speed/120 for class 2 duty cranes.
   b) The long travel and cross travel brakes shall be capable of arresting the motion within a distance in meters equal to 10% of the speed in meters/min. and the retardation due to braking shall not exceed the values as given in the table below:

<table>
<thead>
<tr>
<th>Working condition</th>
<th>Retardation, according to percentage number of driving wheels, $v^2$ (in m/sec$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Outdoor (When $u = 0.12$)</td>
<td>0.9</td>
</tr>
<tr>
<td>Indoor (When $u = 0.2$)</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Legend $u =$ Friction Factor

v) The crane shall be completely assembled and tested in the Supplier's works for full load and 25% overload on hoisting and cross traverse motion, in presence of Purchaser's representative in addition to other tests as specified in IS:3177-1999.

04 STRUCTURAL DETAILS:

i) The crane bridges shall be of welded double/single web box construction and shall be designed as per IS: 807-1976 and/or AISE NO. 6. The materials of construction shall be weldable mild steel in compliance with the relevant standard. However, high strength weldable structural steel also may be used wherever required in compliance with the relevant standards.

ii) The crane bridge girder up to 12-m span shall be in one piece. Girders above 12 m span may be spliced. The number of such splices shall not exceed 2 up to 36 m span. Beyond 36 m span, the number of splices may be 3. Splices shall be designed to resist all the forces and
moments to which it is subjected to, plus 50% thereof.

However, in no case the strength developed by the splice shall be less than 50% of the effective strength of the material.

Splices shall be proportioned and arranged so that the gravity axis of the splice is in line with the gravity axis of the members joined so as to avoid eccentricity of the loading.

iii) Black bolts shall not be used in the main structure of the cranes.

iv) Cross travel rail shall be fixed to the bridge girders by clamping only and not by welding.

v) Transverse fillet welding on load carrying members shall be avoided. All butt welds on tensile zone shall be X-rayed.

vi) Plates, bars, angles and where practicable other rolled sections used in the load bearing members of structures shall not be less than 6 mm in thickness.

vii) The end-carriages shall be of double web plate box construction and shall be connected to the girders by welding at shop or by large gusset plates and fitted bolts to ensure maximum rigidity. Drop stops and jacking pads shall be built-in features of the cranes. Full length chequered plate platforms shall be provided along both sides of the cranes in order to ensure easy access to crane crab, long travel gears and other parts. Safety railings shall be provided on crane bridges and crab frame. Access to the operator’s cabin shall be via staircases only and not through ladders. Platforms to facilitate inspection and dismantling of long travel wheels and main current collectors shall be provided.

viii) Operator’s cabin shall be of welded construction and located below bridge girders. Closed operator’s cabin shall be provided with adequate glazing to ensure good vision in all directions and glazing shall be accessible for cleaning from cabin itself.

Cabin suspension bolts shall be fitted in the reamed holes and the accessibility of these bolts is to be ensured for regular checking

Easy accessibility is to be ensured for cleaning of cabin glasses of fully closed cabin.

ix) The closed cabins shall be equipped with circulating and exhaust fans whereas open cabins shall have only circulating fans.

x) Air-conditioned cabins, if provided, shall be provided with double glazing & heat insulation. The temperature inside the cabin shall be maintained at $25\pm2^\circ C$.

xi) All the cabin floors shall be covered with heat and electrically insulated material. The cabin shall also be equipped with adjustable swivelling type upholstered chair.

xii) The crab frame shall be made of steel plates and rolled sections in welded construction. Crab frame shall be fabricated in one piece if there are no transport limitations. If the trolley is fabricated in more than one piece due to transport limitation, the design of the splice shall be such that one unit of mechanism mounted on one part of the trolley, does not come over the other part.

xiii) Foot-walks shall be of sufficient width to give at least 500 mm clear passage at all points except between railing and bridge girder where this clearance may be reduced to not less than 440 mm.
xiv) Bottom of the drive mechanism of Bridge, Trolley & hoist shall be covered by the platform to avoid any free fall of the loose components lying near to the reducer.

xv) The platforms along the bridge girders and over the crab shall allow convenient access for replacement, inspection, lubrication etc. for different mechanical and electrical components.

xvi) The minimum thickness of chequered plates shall be 6 mm O/P for indoor cranes & 8 mm O/P for outdoor cranes.

05 MECHANICAL DETAILS:

i) Rope drums

Rope drums shall be of cast steel or fabricated out of rolled steel plates. Fabricated drums shall be stress relieved before machining. The grooves of the drum shall be smooth finished. Rope drum shall be flanged at both ends.

ii) Rope sheaves

Rope sheaves shall be of cast steel or fabricated out of rolled steel plates.

iii) Wire ropes

The wire rope shall be hemp cored for all cranes. Ropes shall be regular right hand lay as per IS : 2266-1989. The construction of the ropes shall be 6 x 37 upto 16 mm diameter and 6 x 36 above 16 mm diameter. Wire rope provided in the hoist mechanism shall be in two pieces. Rope balancers shall be provided on the Trolley frame to accommodate two piece rope system.

iv) Hook block

The sheaves shall be fully encased in closed fitting guards fabricated out of steel plates. Smooth opening shall be provided in the guards to allow the free movement of rope, and holes shall be provided for drainage of the oil.

v) Gears & gear-boxes

Straight and helical spur gearing shall be used for all motions. Worm & bevel gearing may be used in exceptional cases with the specific approval of the Purchaser. All first reduction gears shall have helical teeth. All pinions shall be integral with the shaft. All gears shall be hardened and tempered alloy steel having metric module. Overhung gears shall not be used.

Surface hardness for pinion shall be 255 to 300 BHN and for gears it shall be 215 to 260 BHN. Difference in hardness of pinion and gear shall not be less than 20 BHN. All cast steel gear shall be tested by Gamma Ray. All gears shall be enclosed in oil tight gear-boxes. Gearboxes shall be of high grade cast iron/cast steel or fabricated and split at each shaft centrelines. Fabricated gearboxes shall be stress relieved before machining. For Cross-travel and Long-travel motions, vertical gear-boxes with `T' split may be used.

vi) Connection between rope drum & gear-box

One of the following arrangements shall be adopted for connecting the rope drum with the gear-box.
Flexible joint, incorporating flexible geared coupling housed within the drum. Fully flexible geared coupling between the drum and gearbox.

Drive of the drum by means of spur ring mounted on the drum shall be avoided as far as practicable.

vii) Wheels

Crab/crane wheels shall be double flanged. Wheels shall be mounted in anti-friction roller bearing housed in `L' shaped bearing brackets for easy removal during maintenance. Flange-less wheels with guide rollers are also acceptable.

Solid wheels shall be of forged rolled/cast steel. Wheels from 400 mm diameter and above may consist of hardened, rolled / forged steel tyre of not less than 60 mm thickness, shrunk on to cast iron center.

viii) Coupling

Motor shaft shall be connected to the gearbox-input shaft through flexible shock absorbing coupling. Rotating parts shall be suitably covered by 3.15-mm thick sheet steel hinged covers for safety. In case of single motor central drive for Long travel motion, output shaft of the gear-box shall be connected to the line shaft through half geared couplings. Intermediate lengths of the line shaft may be connected through solid flange couplings. Half geared couplings with floating shaft shall be provided between the wheel and the wheel and the line shaft.

ix) Bearings & bearing housings

Anti-friction bearings shall be used throughout except where required otherwise for technical reasons.

x) Buffers

Spring loaded type buffers shall be provided on all the 4 corners of the bridge girders and the end carriages for cross and long travel motions respectively.

xi) Brakes

The brakes shall be provided for all motions on the high-speed pinion shaft of the gear train. For hot metal hoists, two brakes shall be used per motor.

xii) Lubrication

Grouped grease lubrication system shall be used for class M3, M5 and M7 duty cranes. Lubrication of the gears and pinions in the gear-boxes shall be splash fed from the sump. In case of three reductions, vertically mounted gearbox (having limited motion), an oil pump shall be fitted to ensure lubrication of all gears.

06 ELECTRICAL DETAILS

06.01 Scope of supply

The scope of supply covers all electrical equipment commencing from Power Distribution Board (PDB), Isolator, cables, complete down shop leads (DSL) system in the shop and main current collectors on the crane and all other electrical items beyond the main current.
collectors of the crane i.e. DSL main current collectors, power disconnecting switch on bridge platform after main current collectors, protective and control switch gear, motors, control and brake panels, resistors, brakes, limit switches, all power and control cables, socket outlets, lighting distribution panel and lighting fixtures with lamps, festoon cable system for crane trolley magnet/ grab and cable reeling drum, if specified for grab/magnet, master controllers, indicating lamps, push buttons, earthing materials etc. The scope of work also includes complete assembly and wiring and testing of crane at site, erection and testing and commissioning of all electrical equipment, supply of all commissioning spares with minimum quantities as indicated in clause no 04.26, (a) ii of this T.S.

All sundry erection materials required for installation and connecting up of electrical equipment with cable laying and fixing accessories shall be included in scope of supply by Tenderer.

Purchaser will provide 02 nos of 415 V, TPN, 50 Hz of required rating at the incomer of the individual PDB. Purchaser will indicate the required number of PDB with incomer rating, length, number of runs and size of power cables.

06.02 Standards

The design, manufacture, assembly and testing as well as performance of the equipment shall conform to the IPSS in respect of items for which IPSS have been issued; otherwise, to the relevant IS specifications (latest revision). In case the Tenderer is not in a position to comply fully with certain IPSS/BIS specifications, or in respect of certain items for which there are no IPSS/BIS specifications, the Tenderer may base his proposals on IEC recommendations or other reputed national or international standards subject to the approval of the Purchaser.

All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the Government of India and the Government of Chhattisgarh and with the Indian Electricity Rules.

06.03 Climatic conditions

The ambient temperature conditions met within the different shops/ units of the steel works complex will be as indicated in General Specification GS-01.

For specific areas and shops, the ambient temperature conditions indicated above shall be taken into consideration and equipment suitably derated where necessary. For areas not covered above, equipment selection and derating shall generally be based on Ambient temperature of +50°C.

The equipment offered shall be suitable for smooth, efficient and trouble free service in the tropical humid climate prevailing at Bhilai, CG and under the ambient temperature conditions indicated above for the different shops and areas. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

The equipment shall be designed to give efficient and reliable performance under heavy steel mill conditions and shall be such that the risks of accidental short-circuits due to animals, birds or vermins are obviated.

06.04 Power supply and Standard voltage levels

The following standardized voltage levels shall be adopted:

a) **LTAC** : 415V, 3 phase, 50 Hz, 4 wire solidly earthed system. Power supply be made available at this voltage only.
Other voltages shall be obtained by providing transformer/transformer – rectifier unit with MCBs on both primary and secondary side and ±5% and ±10% taps on transformers secondary.

240 V, 110 V AC

c) Socket outlets for

Hand lamps : 24 V, single phase, 50 Hz, AC obtained through suitable transformers

Hand tools : 240 V, 15A, 2 pin plus earth with plug interlocked switch

d) Electro-magnetic brakes : 220 V, DC obtained through individual brake control panels.

e) Monitoring and signaling in electronic installations, mimic panels : 24/48 V. DC

f) Illumination/ lighting : 240 V, AC

The three phase symmetrical short-circuit ratings of the switch gear at 415 V shall be 50 kA for 1 second.

The system/unit/equipment shall be designed so as to be suitable for the following variations in voltage and frequency:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>+10%</td>
<td>+3% &amp; -6%</td>
</tr>
</tbody>
</table>

For LT system

Permissible variations with rated performance, rated current and control effectiveness maintained

Permissible variations for control and regulation equipment with rated performance and control quality maintained

20% of the nominal voltage at the motor terminals. Total voltage dips on starting of large motors on crane shall be limited to 3% on crane and 8% in DSL system.

06.05 Trolley Lines and Power Supply Arrangements for Cranes (DSL System)

01. Trolley power conductors

Crane trolley lines for LRS crane shall be sectionalized with two separate feeding points. Two fully rated MCCB / Isolator shall be provided for each incomer feed point to crane DSL. Sectionaliser MCCB / Isolator shall be provided between the two incoming ACBs with necessary padlocking arrangement. In normal operation the sectionalising MCCB/ACB shall be OFF. The MCCB/ACB and cables upto trolley lines shall be provided by supplier.

Isolator panels shall be provided for the repair section for maintenance by the Purchaser. Necessary DSL arrangement for repair section shall be provided by Tenderer.

When two or more cranes are fed from the same trolley line, hospital bays (repair sections) shall be provided with sectionalizing isolator so that repair or maintenance of any crane can be carried out without disturbing the operation of the other cranes.

Boarding or access platform shall be arranged within the limits of each repair section for approach to be crane.
The conductors shall be supported at 3000 mm intervals by insulators mounted on brackets welded to crane girders. Typical drawings indicating details of trolley line power conductors, supporting insulators, brackets, expansion joints, parallel aluminum bus, signal lamp assemblies etc. shall be furnished by successful Tenderer.

Trolley power conductors shall be of mild steel angle sections. The section shall be straight, unbranded and smooth on the running surface. Joints between lengths of angles shall be welded and all welds shall be finished flush with parent metal. The conductors shall be painted with anticorrosive paint, except for contact surface. Parallel aluminum buses shall be provided as specified. The maximum continuous length of power conductor section shall not exceed 30 m without an expansion joint in between. The power conductors shall be made from standard rolling length. The jointing of standard lengths shall be made by 100% but welding and top surface finished smooth by grinding to get free movement of the current collectors. In order to provide electrical continuity across the expansion joints the power conductors on both sides of the joints shall connected by stranded aluminum conductor jumper, fitted with steel Aluminum strap and lugs suitable for the steel angle sections.

02. Insulators and trolley line holders

The insulators used for the manufacture of trolley line holders shall be preferably steatite, tufnol or porcelain insulation material having substantial mechanical strength specifically against blows and vibrations. They shall be capable of withstanding the impact and shocks resulting from operation of the machine. The creepage distance of the insulators shall not be less than 80 mm.

The insulators used shall have flash over values and mechanical strength not less than the following:

- Dry flashover voltage : 25 kV
- Wet flashover voltage : 12 kV
- Ultimate mechanical strength : 1000 kA

The trolley line holders shall generally conform to the design shown in the drawing to be furnished to the successful Tenderer. All sharp edges shall be ground smooth. The porcelain insulators shall be manufactured and tested as per IS: 1445 – 1997

03. Supporting brackets

The trolley line conductors shall be mounted on holders. The holders shall be bolted on to brackets which in turn shall be welded on to crane girder at stiffeners at regular intervals. In normal run, intermediate type of brackets shall be used, but when sectionalizing gaps or expansion joints are provided, sectionalizing type of brackets shall be provided.

04. Steel to Aluminium straps

These are meant for connecting parallel aluminium bus, at expansion joints, power supply cables from load break switch. They shall be complete with MS cadmium coated bolt nuts, spring washers, lugs etc.

05. Signal lamp assembly

Signal lamp assembly shall be industrial, heavy duty dust tight and water proof in construction suitable for indoor or outdoor locations. The units shall comprise three lamps for three phase with red glass lens and reflectors. The lamp shall be provided with dropper resistance connected in series with the lamp and the resistance shall be rated for continuous
inclusion in the circuit. Alternatively, a built-in transformer may be provided to suit the lamp voltage.

06. Aluminium parallel bus

These buses shall be of E.C. grade aluminium. They shall be free from any deformity in profiles.

06.06 Current Collectors

2 nos. per trolley line shall be provided. The collector shoe will be of heavy duty design and chamfered at both ends, each rated for 100% of total crane rating. Double collectors on each earth trolley line shall be provided and these shall be similar to those on power trolley line. Collector shall be multi hinged for self-aligning. Collector will be designed in such a way that load is transmitted not no the insulators but on the insulator stud to avoid damage to insulators.

06.07 Power distribution on crane

One adequately rated load break manual isolator with locking facility shall be provided immediately after current collectors on incoming line on the crane. The isolator shall be capable of carrying current of two largest motors.

Power from the isolator shall be taken to the air circuit breaker to be provided outside the operator’s cabin or on the bridge depending on the availability of space. In case of pendant operated cranes, this circuit breaker shall be located in protective panel located at bridge platform.

The breaker shall be provided with under voltage, over load and short circuit releases. The breaker shall also be with earth fault protection. The breaker can be closed only when:
- All master controller handles are in neutral position.
- One of the stator or directional contactors are in closed positions.
- Emergency corner switches not operated.
- Door/Gate switch are not actuated and gravity limit switch for hoist motion not operated. Power for lighting and magnet circuits shall be tapped from the incoming side of isolators near current collectors.

06.08 Power supply for CT. motion

Flexible trailing cable systems mounted on retracting support system shall be used. The system shall consist of insulated multi-conductor or several single conductor cable with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cable. The flexible cable shall be EPR insulated CSP / PCP sheathed type.

or rotating trolley cranes, power supply shall be through festoon cable arrangement / rotary current collector. Cable reeling drum or cable basket shall be used for power supply to the magnet from the trolley. Two spare turns of cable provided on cable reeling drum. The cable reeling drum shall be directly driven by hoist mechanism, a clutch shall also be provided to disconnect the drum from hoist mechanism.

06.09 Meters

Ammeter and voltmeter with selector switches shall be provided on the incoming line in operator’s cabin.
Ammeter and voltmeter shall be provided on DC side for Electromagnets.

06.10 Control features

All controls shall be fully magnetic, operated through master controllers. All travel motions shall be provided with plain rotor resistance control with plugging. For long travel drives, the electrical control shall be grouped for the individual pair of motors separately in case of four motor drive and each pair of motors shall be able to drive the crane at reduced acceleration and speed. As an anti-skewing measure, out of a pair of motors for LT., if one drive motor trips, the other drive motor shall also be switched off. For pendant control, plugging shall be avoided for travel motion.

Brakes shall not be used for speed control.

Synchronization of separate drives where required shall be done with the used of solid state thyristor control.

For all hoist motions, except where creep speed is required, plain rotor resistance control shall be provided on all master controller notches in the hoisting direction. The rotor resistance shall be cut out gradually when moving from lower to higher notches such that current peak of 2 times the rated current is not exceeded. In the lowering direction of the motion, controlled lowering shall be provided using one/two plugging notches, one single phasing notch and one/two super synchronous power lowering notches. For obtaining creep speed, conventional methods like planetary gear system, DC. injection (where requirement calls for creep speed in lowering direction only) etc. may be offered.

Hoist control circuit shall also be provided with anti-drop feature i.e., whenever the master controller is brought back to zero position from higher notches in both directions, the motor shall automatically be connected to hoisting direction for some time (time adjustable through timers) to avoid the downward drift of the load. Brakes shall be clamped in zero position of the master controller.

06.11 External control of auxiliary hoist and CT of LRS Crane

Tenderer shall supply one no. of Ground Control Post in Pedestal for installation in PCM control room. The control post shall have following facilities:

a) Control on PB- This shall transfer the control of CT and auxiliary hoist from cabin, master controller to ground control post and will not allow LT motion from cabin.

b) For CT and aux. Hoist 4 push buttons each (total 8 PBs) shall be provided on ground control post for following application:

- 10% speed of hoist & lower
- 30% speed of hoist & lower
- 10% speed of CT forward & reverse
- 30% speed of CT forward & reverse

The control post shall be connected to the main control of cabin on crane through hear resistance flexible cable with copper conductor arrangement and plug and socket system. The socket shall be fixed to the cabin. The no. of pins for socket, no. of additional aux. Contactor, no. of cores for flexible cable to achieve the above control shall be decided by the Tenderer during detail engineering and shall be included in the scope of supply of Tenderer. Further, Tenderer shall quote radio control system to achieve the above control requirement as an optional feature. Cost for the radio control option shall be indicated separately.

06.12 Thyristor control drives
Thyristor control shall be provided for all the cranes operating in areas where ambient temperature is more than 50 deg.C and for Mixer Charging Crane. Control shall be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed shall be 10% or lower as per operational requirements of rated speed. The thyristor regulator shall be fully controlled and suitable for four quadrant operation.

Speed control of the slipring motor shall be achieved through regulation of stator voltage with resistance in the rotor circuit, if necessary. The reversal of direction shall be through thyristor / magnetic contactor which shall open and close at zero current.

The continuous rating of the thyristor shall be at least 2.0 times the motor rated current at mechanical KW and the converter shall be designed and rated for load requirement taking care of peak currents during acceleration, normal operation and regeneration conditions. The dv/dt and di/dt rating of the thyristors shall be suitably selected.

The repetitive PIV rating of semiconductor devices shall not be less than 2.5 times the peak of normal system voltage. Thyristor bridges shall include R.C. snubber circuits across the thyristor, high speed semi-conductor fuses with micro-switches for monitoring of failure. Closed loop regulation suitable for the system with various feedback such as speed, current etc. shall be provided. Speed feed back shall be through tacho-generator of permanent magnet type mounted on the non-driving end of the motor shaft. The regulation shall include ramp generators, potentiometers for various setting, various regulators, signal conditioners, logic command module sequence, module, trigger module, zero and over speed monitor, torque less protection module etc. as per the requirements. The control and regulation equipment shall be able to maintain their rated performance and control quality even under conditions of variation of +10% and - 15% in voltage and +5% in frequency. A zero current sensing device shall be incorporated. The reversing of stator contactor shall be done at zero current. Braking down to zero speed shall be electrical with mechanical brake setting only at zero speed. Protective features like anti-drop etc. shall be incorporated to prevent load setting. The circuitry shall also provide for the protection against failure of motor torque such that the mechanical brake sets in such cases. All other features of conventional crane controls shall also be built into the scheme. The following shall also be provided on the A.C. side.
- Surge suppressor
- Over current protection
- Overload protection
- Single phase protection
- Phase sequence protection
- Ammeter and voltmeter with selector switches
- Isolating switches

Control and auxiliary supply shall be provided with separate transformer and under voltage protection. The test shall be performed as per IEC: 146. Details of the system offered shall be furnished along with necessary single line diagrams and block diagrams. All the control modules shall be grouped in a sheet steel enclosure. The control module cards shall be made of epoxy glaze and suitable for plugging into the racks. The cards shall be locked into the rack, which carries a sealing bar and assists locking of the cards thereby cutting down on the wear of the printed circuit connector contacts which can be subjected to high rate or vibration and further avoid the disconnection of cards from the connector. The thyristor panel shall be suitably mounted so that little vibrations are reflected to the components and connection.
The cables for the thyristor controller and associated equipment shall be laid and clamped separately on the crane as far as possible.

06.13 VFD control drives

VFD control shall be provided for cranes operating in areas where operating temperature is 50 deg. C. Control shall be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed shall be 10% or lower as per operational requirements of rated speed. The VFD shall be fully controlled and suitable for four quadrant operation.

06.14 Variable Voltage Variable Frequency (VVF) Drive

**1.0 Basic design particulars**
- Digital control technology with vector control (with / without PG as per requirement).
- IGBT based with sine coded PWM control.
- Industrial and continuous duty.

**2.0 Type of connection**
Three phase frequency converters with rectification and inversion i.e. variable voltage and variable frequency output with current source / voltage source (PWM) inverters.

**3.0 Overload capacity**
- 150% of the rated current for 1 minute following 100% load & to meet the drive overload capacity.
- 200% for 3 sec.

**4.0 Efficiency**
More than 96% at full speed and load.

**5.0 Input power supply**
- 415 V AC + / - 10%.
  - 3 phase.
- 50 Hz + / - 5 %.
- 4 wire neutral earthed system.

**6.0 Regulated power supply for reference setting**
- Voltage variation of (+/-) 0.1 % with an input variation of +10% - 15%.
- Steady state regulation of (+/-) 0.25% guaranteed against 100 to 200 % load disturbance and + 3%, -6% input supply frequency variation.

**7.0 Input reference voltage**
- 10 V DC to 0 V to + 10 V DC / 0 - 10 V DC / 4 mA to 20 mA.

**8.0 Output frequency**
- 0.5 - 400 Hz.
**9.0 Output frequency resolution**
- 0.01 Hz.

**10.0 Starting torque**
- 150 % / 1 Hz. (without PG)
- 150 % / 0 RPM (with PG)

**11.0 Torque accuracy**
- + / - 5 %.
**12.0 Speed control accuracy**
- + / - 0.02 %.

**13.0 Ramp rate**
Linear acceleration and deceleration adjustable independently from 0 to 999.9 seconds.

**14.0 Vibrations**
Suitable to withstand vibrations more than 0.5g.

**15.0 Main power components in incoming AC side**
- ACB/MCCB with 50 KA rating
- Matching input isolation transformer / line reactor for harmonic and noise suppression.
- AC line surge suppression network.
- Input contactor.

**16.0 Converter – Inverter**
- Diode bridge/ Thyristor bridge for AC/DC.
17.0 Load side components
- Filter network
- Over-load relay for each motor.
- Output contactor in output side.
- Output reactor / terminator

18.0 Diode Bridge
- Minimum ratings of Diode cells.
  - PIV rating : 2.5 times the peak value of line voltage
  - dv/dt rating : 200V/microsecond for voltage control and 1000V/microsecond for inverter control.
  - di/dt rating : 100A / microsecond.

19.0 Protective features
- AC line surge suppression network and overvoltage protection.
  - Under voltage in supply network
  - Phase sequence protection and monitoring
    - Under voltage in DC bus
    - Over voltage in DC bus
    - Over speed monitor
      - Over load
      - Earth fault
    - Instantaneous over current
    - Transformer fault ,If applicable
    - Cooling fan failure – Stall monitor for motor alarms.

20.0 Annunciations
- Following faults shall be annunciated in keypad of the drive / HMI.
  - AC line surge suppression network and overvoltage protection.
  - Under voltage in supply network
  - Phase sequence protection and monitoring
    - Under voltage in DC bus
    - Over voltage in DC bus
    - Over speed monitor
      - Over load
      - Earth fault
    - Instantaneous over current
    - Transformer fault ,If applicable
    - Cooling fan failure
    - Stall monitor for motor alarms.
    - Motor fault (winding / bearing temperature, vibration) as applicable
    - Loss of frequency command
  - Shall be able to store at least 16 previous faults in memory on FIFO sequence.

21.0 Meters
- Output voltmeter and ammeter with selector switches.
- Input volt meter and ammeter with selector switches
- Output frequency meter
22.0 Selector switches

- KW meter for drive ratings above 200 KW.
- Local / Remote.
- Auto / Manual.
- Main / Bypass.

23.0 Pushbuttons

- Trip reset.
- Start.
- Emergency stop.

24.0 Lamps

- Drive ready.
- Drive trip.
- R, Y, B phase power ON.
- Control supply ON.

25.0 Regulation & control facilities

- Reference speed setter
- Ramp generator
- Speed feed back
- Current feed back
- Trigger module
- Pulse transformers
- Logic control module
- Sequence module
- PID control
- Zero speed / over speed monitor as applicable.
- Momentary power loss restart.
- Auto tuning.
- Current limiter
- Counter current / regenerative braking unit as applicable
- Active electronic components used shall be of industrial grade hermetically sealed.
- Output signals for fault alarm, frequency arrival, running signal.

26.0 Remote control facilities

- Shall have transducer to monitor the outputs like motor speed at remote place /HMI.
- Facility to accept speed reference from HMI / engineering station.

27.0 Operator panel

- Shall be mounted on the front door of the unit.

28.0 Membrane keypad

- The keypad shall be logically designed for two operating areas with required number of keys.
- Local operator control like local start /stop , Jog forward / reverse.
- Programming.

29.0 LCD display

- Display shall be black lighted, enabling viewing in extremes of lighting conditions.
- Display shall be in alphanumeric (in English only)
- 16 characters, 2 lines.
- All the last 16 faults stored in memory (in FIFO sequence) shall be displayed by scrolling.

30.0 Construction features

- Floor mounted, free standing
- Dust and vermin proof
- Sheet steel clad
- Minimum 2.5 mm thick for panels.
- Minimum 2.0 mm thick for doors and side covers.
- Suitable to withstand vibrations to be
31.0 Enclosure and ventilation

Enclosure conforming to IP-52 or better with weather proof enclosures
Units shall be provided with cooling fans and louvers at the bottom sides.
All louvers shall have fine mesh behind them.
Ventilation through individual ventilation ducts, from bottom not acceptable.

The VVVF shall have a separate module / card for hoisting / lowering motion.

06.15 Panels

There will be separate panels for each motion in addition to the protective panels and resistance panels.
All panels shall be of free-standing floor-mounting construction, suitable to withstand vibrations encountered on crane. Hinged doors shall be provided for closed type panels. Panels shall be front wired. Front wired live points of bottom most equipment shall be mounted at least 350 mm above the bottom cover of the panel. Panel shall be fabricated from 2.0 mm thick steel sheet.
Power and control terminals shall be segregated. 10% spare terminals shall be provided in each panel.
Equipment in the panel shall be so mounted that their removal or replacement from the front is easy.
Separate control panel for each motion shall be provided.
Panels shall be of closed type when mounted on bridge platform.
The panels shall be mounted along the girder facing the hand railing. Sufficient clearances shall be provided between the panels. A minimum clearance shall be provided in front of the panels for walkway and approach as per I.E. Rules. The panels shall be supported in the back from the girder to avoid vibrations. Open type panels may be used for installation inside the box girders. In this case, adequate lighting and ventilation shall be provided for the room.

06.16 Switchgears

Each mechanism motor shall be provided with MCCB, contactors on stator and rotor sides, oil dash pot type over load relays and suitably rated rotor resistances. In case of thyristor controlled drive, each mechanism motor shall be provided with breaker / switches, transformer, thyristor, rotor resistances, contactors on stator and rotor side etc. Each motor shall be fitted with a tacho-generator for speed feedback. The overload capacity of thyristors shall be as per IEC. The speed range shall be 0-120% of rated speed.
MCB shall be provided in the control circuit of each motion.
Each brake circuit shall be provided with a suitable contactor.
Rating of contactor selected for any mechanism shall be at least 50% higher than the respective motor full load current for the mechanism at 40% duty cycle. The minimum rating of the contactor used shall be 30A and the life of each contactor shall not be less than 10,000 hrs. of operation.
Reversible directional contactors shall be inter locked both mechanically and electrically.

06.17 Motors
Heavy duty reversible crane service, totally enclosed fan cooled, foot mounted, wound rotor motor conforming to latest edition of IS: 325-1996 shall be used for various drives. Class of insulation shall be F/F (Stator/Rotor) with temperature rise limited to that for ‘B’ Pullout torque to the not less than 225% and 275% of full load torque corresponding to 40% CDF for class M3 & M5 and class M7 & M8 duty cranes respectively.

Motor selection shall be done as per IS : 3177 – 1999.

The main motor shall have following speed ranges:

a) Class M3 & M5 duty cranes:
   Main & auxiliary hoist  750 rpm
   Long & cross travel 1000 rpm

b) Class M7 & M8 duty cranes:
   Main & auxiliary hoist  600 rpm
   Long & cross travel 750 - 1000 rpm

All motors shall have the terminal box at top. Frame sizes shall conform to IEC Standards. Horizontal foot mounted and with tapered shaft extension.

While selecting the motor rating following shall also be taken into consideration:

- Duty type S4 & S5
- Cyclic duty factor
- Number of switchings per hours
- Type of controls used
- Inertia of the motor and mechanism
- Ambient correction factor
- Service factor
- Derating for thyristor control
- Wind pressure

Maximum permissible operating speed shall be 250% of synchronous speed or 2000 rpm whichever is less. Over load capacity 150% of full load current for 2 minutes without damage or permanent deformation.

06.18 Brakes

Brakes shall be D.C. electromagnetic type confirming to AISE Standard. The brake coils shall be made of copper and of insulation class ‘F’.

Brakes shall be designed to fail safe whenever the current is interrupted either intentionally or by failure of the main supply.

Brake circuit forcing shall be provided for D.C. brakes. D.C brake circuit shall be switched off on D.C. circuit for quick operation of brake.

A separate set of parking brake for L.T. motion shall be provided for each out door crane. Power supply for these brakes shall be obtained from protective panel.

06.19 Limit switches

Roller lever operated, resetting limit switches shall be provided for all travel motions. For each hoist motion, a rotary cam type over hoist and over lower, self resetting limit switch shall be provided. This limit switch shall have independently adjustable cams for hoisting and lowering motion. The cams shall have adjustability such that end limit can be set to within 100 mm of the hoisting or lowering motion. In addition to this, a back up ultimate limit switch of series/ shunt gravity type shall be provided to prevent over hoist. The later shall be of manual reset type. In case of cranes handling hot metal, the gravity limit switch shall preferably be of shunt type. Provision shall be made to bridge the gravity type limit switch contact by push button/ switch or any other means to lower the load. An indication shall be provided to the operator whenever this limit switch has operated. Suitable limit switch shall be...
provided for slack rope, gate/door opening, slew mechanism, grab closing / opening etc. wherever necessary.

06.20 Anti-Collision Devices
In cranes where two or more cranes are operating in the same bay (at same or different level) all cranes shall be provided with suitable Anti-collision system. Anti-collision device shall be optical type.
A sound signal shall be provided to the crane operator when they are at certain safe distance apart (preferably distance to be adjusted as a function of speed at site) and crane shall stop. After few seconds, it shall be possible to run the cranes towards each other (or only one crane can move towards the other) till buffers of the cranes meet by providing “by pass” in the operators cabin.
Anti-collision shall also be provided on trolley for twin trolley cranes along with suitable by pass arrangement.

06.21 Resistances
Air cooled, robust, heavy duty, corrosion resistant punched stainless steel (AISI-406) grid type. Resistance shall be in step wise execution. In a particular box the rating of resistances shall be the same to the extent possible. Resistance shall have vibration proof only.
Rated for 10 minutes duty. Continuous duty rating of resistances shall be provided in case of hoist motions controlled by thyristor converters.
Maximum temperature of resistor elements shall be limited to 2750 C at desired duty.
Suitable tapping points shall be provided.
Resistance boxes shall be mounted in racks that permit independent removal of any selected box.

06.22 Master controller
Cam type master controller with joy stick type lever shall be used.
Separate master controllers for hoist, LT & CT shall be provided.
Dual master controller operated with single handle shall not be used.
Master controller for each motion controls shall have four / five notches in each direction.
Master controller shall have three positions i.e Lift - Off - Drop. It shall have spring return from drop position to Off position.

06.23 Lighting, socket outlets, bells etc.
Lighting shall be provided in operator’s cabin, staircases, platforms and working areas.
Minimum 4 nos. 400 watts high pressure sodium vapour flood lights equally spaced (under crane girders) about the crane span shall be provided along with shock absorbing and anti-swing suspension arrangements. More numbers of fittings shall be provided if required for cranes with longer span and/or longer height of lift.
Fluorescent lamps with necessary fittings shall be used for operator’s cabin, staircases, platforms etc.
Adequate number of hand lamp socket outlets (2 Pin, 10A, 24V) and power socket outlets (3 Pin, 20A, 240V) shall be provided along with switches socket & switch shall be interlocked suitably. A hand lamp (160W SLS lamp with enclosed type battery and wire guard) along with sufficient length (15m) of cable with a plug shall also be provided for each crane.
An alarm bell shall be provided on each crane.

06.24 Electromagnets
All magnets shall be suitable for steel plant application and shall be welded construction.
Magnets shall be rated for 230 V DC and suitable transformer – rectifier units shall be provided for feeding them. Rectifiers shall also be suitable protected by suitable protective device.
Magnets shall be class ‘H’ insulated, at least 50% rated, copper conductor would and shall have surge suppressor box and separate in terminal box for termination of cable. Magnets for production cranes handling hot products shall be 75% rated. Surge suppressor shall be compact, non-linear resistor silicon carbide thyrector, variator or metrosil type. Each magnet shall be provided with suitable plug socket unit. One earth terminal on magnet to be connected to spare core in magnet cable. Wherever specified, a set of batteries, a battery charger, one annunciation system and other accessories shall also be provided along with magnet so that the magnet can hold the full load for at least 20 minutes in case of power failure.

06.25 Equipment in operator’s cabin or on pendant unit

a) In case of pendant controlled crane following shall be included on the pendant unit:

<table>
<thead>
<tr>
<th>Push button for</th>
<th>Hoist slow, hoist fast, lower slow, lower fast, left cross traverse, right cross traverse, forward long travel, backward long travel, emergency stop conditions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch for</td>
<td>Lights and bells</td>
</tr>
<tr>
<td>Lamps for</td>
<td>Power ‘ON’ indication and emergency corner switch operation.</td>
</tr>
</tbody>
</table>

b) In case of cabin operated cranes:

The operator’s cabin shall contain the following:

- Master controllers for all the motions and magnet (wherever applicable).
- Emergency stop push button.
- Foot switch for alarm or bell.
- Switches for all lighting equipment on crane.
- Switches for air conditioner, exhaust fan and for cabin fan.
- A fire extinguisher.
- Insulating mat and operator’s chair.
- Cabin light.

Annunciation panel with indication lamps for power ‘ON’ control ‘ON’ emergency corner switch operated, ammeter and voltmeter with selector switches.

c) In case of master controller operated cranes:-

In this case there should be the facility of controlling the crane from the control pulpit.

All the control facility available in case of operating from the operator’s cabin is duplicated in the control pulpit through the cable.

d) Radio remote control:-

In this mode of control system, all the 3 motions
- Hoist.
- Cross travel.
- Long travel.

can be controlled.

The system shall have capability to provide range of 1.5 times the long travel distance of the crane.

In the case of signal failure, all motion shall come to a safe stop.

The system shall have facility of controlling speed in two steps:-
Slow speed on the first step of the breaker contact / pushbutton of the radio remote control representing the first or second notch of the master controller.

Full speed on the second step of the breaker contact / pushbutton of the radio remote control representing the final notch of the master controller.

Transmitter :-

Transmitter shall have following features:-

- Constructed with sophisticated microprocessor technology and surface mounted electronics.
- Transmission type :- FM FSK
- Transmission speed :- 9.6 Kbps.
- Built in self test for all functions.
- Transmitter shall consist of switching breaker, dial switch and push buttons.
- Switching breaker shall be non locking to zero position or maintained function.
- Indications :
  - Operation status
  - Battery status
  - Indicators that display information from crane.
  - PIN - code (Personal Identification Number)
  - Internal antenna.
  - Rechargeable battery.
  - Battery 7.2 V NiCd
  - Operating time :- About 8 hours.
  - Different operating frequencies (minimum 16 nos.)
  - Two hand upstart.
  - Stop push button.
  - Operating conditions :- Areas having large temperature variations, dusty, more vibrations, oil and humidity.
  - Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C
  - Protection class : IP - 54.
  - Casing material : Polycarbonate / ABS plastic.

Receiver :-

Receiver shall have following features :-

- Upto 20 functions exclusive safety relays (for transmitting preset reference values to VFD in the crane).
- 2 safety relays (for control of main contactor)
- Power supply suitable for 240 V AC, 6 A.
- Minimum 16 different operating frequencies.
- Two redundant microprocessors for monitoring each others.
- Cyclically redundancy checks check for high secutity of transmitted radio messages.
- Frequency scanning in the receiver.
- Memories last 10 users.
- Interlocking of the relays.
- Momentary or latched relay functions.
- Two hand up start ( to avoid unintentional start).
- Protection class : IP - 65.
- Casing material : Aluminium profile for fast mounting on DIN rail.
- Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C
- Resistance boxes : IP 11
- Motors : IP 55
- All other electric equipment : IP 54

b) For outdoor operations
- Resistance boxes : IP 33 with canopy
- Motors & panel : IP 55 with canopy
- All other electrical equipment : IP 65 with canopy

06.27 Cables

Power cable suitable for 3 Phase, 4 wire, AC power supply system.
All cables shall have stranded copper conductors. Control wiring shall be with 2.5 mm² copper; minimum size of power cable shall be 4.0 mm². Fixed wiring on cranes shall be carried out with PVC insulated. PVC sheathed armoured cable or HRPVC insulated HRPVC sheathed cable or better.
All flexible cables (i.e. cables for magnet, trolley, feed, pendant unit etc.) shall have copper conductor, EPR insulation and CSP / PCP sheathing or better.
All cable shall be suitably de-rated for grouping and higher ambient temperature.

All cables shall be of 1100 Volts grade.
All accessories like cable glands, clamps, pipes, wire and terminal marks etc. shall also be provided.
Cable laying and terminations shall be such that the chances of cables getting damaged is remote.
Cable sizes shall be selected considering motor rated current.
In all passages and on trolley the cable shall be laid in trays and shall be covered by similar trays and properly clamped & fixed.

a) LT Power Cable
1.1 kV, heavy duty power cable, 4/3 core with stranded sector shaped (sm) or with compact circular stranded (rm/V) or circular stranded (rm) Copper conductors as applicable, PVC insulated suitable for 70°C operation as per IS:5831-1984, core stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi core conforming to IS:1554 (Part-I – 1988) Type TWY.

b) Control Cables
1.1 kV, circular stranded (rm), annealed copper conductor, PVC insulated suitable for 70°C operation, as per IS:5831-1984, cores stranded together provided with a common covering of PVC inner sheath, galvanised round steel wire armoured and PVC outer sheathed, multi-core similar to IS:1554- (Part-I)-1988, Type YWY.

c) Flexible Trailing Cable

06.28 Earthing

A ring earthing system shall be provided on the crane. Each and every electrical equipment shall be connected to this earthing at least at two points. However the electronic circuit insulated earth wire shall run in panel and terminate at main earth connection only at one point. The earthing shall be connected to the fourth trolley line in DSL system through 2 nos of current collector. Additionally current collectors shall also be provided on crane rails for earthing on crane. All these collectors shall be connected to earthing ring.
An earth core shall be provided in trolley feed cable and the magnet. The cable reeling drum shall have a separate slipring for earthing purpose. It shall conform to general specification for earthing. Rubber mattings shall be provided in front of the protective and control panels. All bonds between earth conductors and crane parts shall be welded if possible, or rivetted and soldered. Where screwed bonds are made, care shall be taken that there is satisfactory contact surface and nuts shall be locked to prevent their loosening. Earth connections to equipment shall be made by means of multi strand flexible conductor to adequate section. The earth ring on the crane/ machine shall be connected to the plant earthing system through to gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system. In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks. Flexible copper bonds shall be provided across any gap in the running gantry rail. For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

06.29 Colour code for electrical equipment

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description of equipment</th>
<th>Colour</th>
<th>Paint shade No. as per IS : 5-1991</th>
<th>Equivalent RAL Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>MOTOR</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>1.</td>
<td>6.6 kv motors</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>2.</td>
<td>LT AC Motors (415v or below)</td>
<td>Brilliant Green</td>
<td>221</td>
<td>6010</td>
</tr>
<tr>
<td>3.</td>
<td>Large Custom Built DC Motors</td>
<td>Light gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>4.</td>
<td>DC 460 V Motors</td>
<td>Azure Blue</td>
<td>104</td>
<td>5000</td>
</tr>
<tr>
<td>5.</td>
<td>DC Motors upto 250 V</td>
<td>Oriental Blue</td>
<td>174</td>
<td>5018</td>
</tr>
<tr>
<td>II</td>
<td>Mounted Electrics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Equipment installed on or alongwith motor (Viz Tacho-generators, brake etc.)</td>
<td>Same as that or motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Equipment installed on mechanism but separate from motor (Viz. Limit switches, pull cords, speed switches, load calls, photo elec. relays etc.)</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>III</td>
<td>Transformers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Outdoor transformers (incl. Their associated equipment/ panels installed outdoors)</td>
<td>Aluminum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Description of equipment</td>
<td>Colour</td>
<td>Paint shade No. as per IS : 5-1991</td>
<td>Equivalent RAL Code</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------</td>
<td>-------------------------</td>
<td>-----------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>2.</td>
<td>Indoor transformers</td>
<td>Dark Admiralty Gray</td>
<td>632</td>
<td>7012</td>
</tr>
<tr>
<td>IV</td>
<td>Switchgear of substation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>6.6 kv switchgear</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>2.</td>
<td>415 switch gear (Substation equipment)</td>
<td>Brilliant Green</td>
<td>221</td>
<td>6010</td>
</tr>
<tr>
<td>V.</td>
<td>Control Gear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>All control panels (MCCs, PDBs, thyristor panels etc.)</td>
<td>Light Admiralty Gear</td>
<td>697</td>
<td>7001</td>
</tr>
<tr>
<td>2.</td>
<td>Light distribution board</td>
<td>Brilliant Green</td>
<td>221</td>
<td>6010</td>
</tr>
<tr>
<td>3.</td>
<td>Fire fighting panel</td>
<td>Post Office Red</td>
<td>538</td>
<td>3002</td>
</tr>
<tr>
<td>4.</td>
<td>Local control box</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>5.</td>
<td>PLC, UPS, Control desk, Mimic panel</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>6.</td>
<td>Pulpit equipment</td>
<td>Light Gray</td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>VI.</td>
<td>Miscellaneous Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Junction boxes</td>
<td></td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>2.</td>
<td>Conduit pull boxes</td>
<td></td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>3.</td>
<td>Light fittings</td>
<td></td>
<td>631</td>
<td>7042</td>
</tr>
<tr>
<td>4.</td>
<td>Welding sockets/ power sockets</td>
<td>Green</td>
<td>221</td>
<td>6010</td>
</tr>
<tr>
<td></td>
<td>- 415 V</td>
<td>Light Orange</td>
<td>557</td>
<td>2000</td>
</tr>
<tr>
<td>5.</td>
<td>110 V and 24 V transformer, sockets, lamp sets etc.</td>
<td>Canary yellow</td>
<td>309</td>
<td>1016</td>
</tr>
<tr>
<td>6.</td>
<td>Earthing strip</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Battery charger</td>
<td>Brilliant Green</td>
<td>221</td>
<td>6010</td>
</tr>
<tr>
<td>8.</td>
<td>DC DB</td>
<td>Oriental Blue</td>
<td>174</td>
<td>5018</td>
</tr>
<tr>
<td>9.</td>
<td>Battery charger cum DC DB</td>
<td>Brilliant Green</td>
<td>221</td>
<td>6010</td>
</tr>
</tbody>
</table>
15-A.03 DOCUMENTATION

1. Information to be furnished by the Tenderer along with the tender:

The tenderer shall submit adequate sets of following technical drawings & technical data/information with tender for cranes without which the tender shall be considered as incomplete & may not be considered for acceptance.

   a) General arrangement drawings/clearance diagram of the cranes.
   b) Filled up questionnaire
   c) List of commissioning spares
   d) List of spares for two (2) years normal operation and maintenance
   e) List of insurance spare for each crane
   f) List of special/maintenance tools & tackles.
   g) Un-priced copy of list of equipment.
   h) List of Preferred Makes.

2. List of drawings/documents to be furnished by the successful Tenderer for approval

   a) General arrangement drawing of crane showing full details in plan and sections.
   b) General arrangement drawing of trolley/hoist blocks.
   c) Quality Assurance Plan for inspection.
   d) Detail specification of motor indicating type, KW, rpm, starting torque requirement, class of insulation, type of enclosure, frame size etc.
   e) Power requirement, details of motors, control scheme.
   f) List of spares for 2 years normal maintenance.

3. List of drawings/documents to be submitted along with equipment by the successful Tenderer

   a) GA drawings, complete assembly and sub assembly drawings of the equipment.
   b) Drawings of all equipment/component received from sub supplier.
   c) Test and warranty certificate for each item of equipment.
   d) Test reports and inspection reports.
   e) Instruction manuals for testing and commissioning.
   f) Operation, maintenance and safety manuals.
   g) Requirement of special tools and tackles.
   h) Detail drawing list and specifications of all wearing out parts and parts subject to breakage during normal operating conditions.
   i) List of spare parts with drawings, sketches, specifications and manufacturer's catalogue.

15-A.04 QUESTIONNAIRE (DOUBLE GIRDER/FOUR GIRDER EOT CRANE)

1. DPR/TPR/ Crane No.
2. No. Off
3. Type of Crane
4. Supplier/Make
5. Capacity (t)
6. Span (m)
7. Duty Class
8. Speeds (normal & Creep) m/ min
a) Main hoist & creep
b) Aux. Hoist & creep
b) Cross travel
c) Long travel

9. Height of lift (m)
a) Main hook
   Above floor
   Below floor
b) Aux hook
   Above floor
   Below floor

10. Crane rail height above floor (m)

11. Max wheel load (t) (without impact)

12. Type of cabin

13. Type of hook:
a) Main hook
b) Aux hook

14. Location (Indoor/ Outdoor)

15. Hook approaches (m)
a) Main hook
b) Aux hook

16. No of rope falls, dia, construction, & breaking strength for
   a) Main hoist
   b) Aux hoist

17. Gantry rail size

18. Crab rail size

19. Over buffer dimension (m)

20. Wheel base

21. Wheel diameter for
   a) LT wheel
   b) CT wheel

22. Handling attachments

23. Special features (weighing device etc)

24. Motor:
   (Type, kW, rpm starts/ hr enclosure etc)
a) Main hoist
b) Aux hoist
c) Cross travel
d) Long travel

25. Type of control for each motion with corresponding characteristic curve:

26. Method of obtaining creep speed:

27. Power supply
   - Power supply S.L.D:
   - Electric equipment specification

28. Control voltage

29. Ambient temp/ Environment

30. Total weight of the crane (t)

31. Break up of crane weight (t)
a) Structural
b) Mechanical
c) Electrical

32. Total weight of the crab (t)

33. Code of design

34. General arrangement drawing, incorporating the front and side elevations, plan, hook
approaches, location of cabin/ pendant, down shop lead, clearance dimension, handling attachments and other relevant characteristics of the crane.

35. Details of swiveling / rotating arrangement, if any, along with scheme.

36. Any other information
15-B SINGLE GIRDER EOT/US CRANE

15-B.01 The scope of work of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection testing & commissioning of Single Girder EOT / Under Slung Cranes of various capacity.

15-B.02 Technical Specification

- Single girder cranes shall be designed, manufactured, assembled and tested in accordance with the latest revision of IS:807, IS:3177, IS:3938 and other relevant codes and practices for the cranes to be used in steel plants, steel industry (IPSS) unless otherwise stated.

- The components of the hoist shall be designed, manufactured, assembled and tested in accordance with the latest revision of IS:3938 and shall be of standard make.

- All working parts requiring replacement or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

- All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and tested.

- For out-door cranes all electrical and mechanical components which are exposed to weather shall be completely covered or made weather proof. The covers shall be in segments to facilitate easy dismantling and assembly.

- No cast iron parts shall be used except for electrical equipment and no wood or other combustible material shall be used unless specifically mentioned otherwise.

- Where down shop leads are located below runway rails, guard shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads.

- All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washers.

- All trailing cables shall be clamped with PVC or non-metallic clamps.

- Steel frames carrying machinery shall be machined to true surface.

- All gears and bearings shall be lubricated by splash lubrication/ grease as required. All greasing points shall be easily accessible.

15-B.03 Structural Design

- The crane structure shall be designed in accordance with the latest revision of IS:807.

- The bridge girder shall consist of main and an auxiliary structure where necessary.

- End-carriages shall be fabricated from rolled steel sections or plates, or both, welded together to form a box.

- End-carriages shall be of ample strength to resist all stresses likely to be imposed on them under severe conditions, including collision with other cranes or stops. The length of the end-carriage shall be such that no other part of the crane is damaged in collision.

- The end-carriage shall be fitted with safety stops to prevent the crane from falling more than
25 mm in the event of breakage of a track wheel or axle. Suitable jacking pads shall be provided on each end-carriage for jacking up the crane while changing track wheels.

- For single girder EOT cranes with central L.T. drive, full length M.S. chequered plate platform shall be provided along the bridge girder for mounting and access to long travel drive, current collection system, control panels, etc. A clear head-room of minimum 2000 mm shall be made available over the top of platform from the bottom cord of the roof truss.
- Black bolts shall not be used in the load bearing structures of the crane. Also high tensile friction grip bolts shall not be used unless approved by the Purchaser.
- Bolts used in shear shall be fitted into reamed holes.
- Transverse fillet welding on the load carrying members shall be avoided.
- All butt welds on structural members, subject to tensile stress, shall be x-rayed.
- Plates, bars, angles and where practicable, other rolled sections used in the load bearing members of the structure shall not be less than 6 mm thick.
- Steel sections and plates, used for construction shall be of the latest revision of IS:2062 quality.

15-B.04 Mechanical Equipment

a. Design of Mechanisms

Each mechanism of the crane shall be modular in construction with built in facilities for easy dismantling and maintenance of each assembly as an independent unit.

b. Rope Drums

Fabricated rope drum shall be stress relieved before machining. For the cranes used in steel plants, the material of the rope drum shall be limited to C.S. / M.S.

c. Wire Rope

The wire ropes shall be regular right hand lay hemp cores as per IS: 2266/1989. However, ropes working under water and in corrosive atmosphere shall be galvanized and shall have steel core. For rope arrangement with 2 falls, wire rope shall be of non-spinning type. For the cranes in steel plant, selection of wire rope shall be as per IPSS.

d. Rope Guides

Suitably designed rope guides with pressure ring/ rope tightener shall be provided for each lead of rope from the rope drum to prevent the rope from overriding, loosening or rope coming off the groove.

e. Rope sheaves

For cranes in steel plants, material shall be either CS/MS. Bottom block sheaves shall be provided with suitable guards to retain the rope in the sheave groove. Equalizer sheave/ bar shall be arranged to turn and swivel to maintain rope alignment under all circumstances.

f. Wheels

For single girder EOT cranes, the wheels for long travel motion shall be double flanged with straight tread. The width of wheel tread shall be greater than the rail head by 30 mm. For under slung cranes hoists block, the wheels shall be single flanged with straight/ taper tread to suit the track beams. Minimum diameter of the LT wheels for S.G. EOT cranes shall be 320 mm. However, in case of steel plant duty cranes the combination of wheel diameter and
rail size shall be ensured. Wheels shall be of forged/ rolled/ cast steel with minimum hardness of 200 BHN in case of single girder under slung cranes running on rolled steel joist and 300 BHN for EOT cranes and for under slung cranes/ hoists running on wear resistant flats welded to rolled steel joists. Minimum diameter of CT & LT wheels for under slung cranes shall be 150 mm.

g. **Long Travel Drive**

a) **For Single girder EOT Cranes**

Individual wheel drive (one wheel in each end-carriage) shall be provided when the crane span exceeds 13 meters. All parts of the long travel drive shall be located above the platform and easily accessible. The gear-box mounted on platform with foot mounted motor and brake shall be connected with driving wheel by means of locating shaft and flexible geared coupling. The use of open gearing, chain and sprocket, pulley and belt etc. is not permitted.

b) **For under Slung Cranes**

Dual drive arrangement located at either end of each end carriage shall be provided. Flange mounted geared motors may also be used.

h. **Hoist and Cross-Travel Drive**

The hoist and cross travel motions shall be combined in one block which shall be designed as per IS:3938/1983. It shall be ensured that skidding does not occur under any condition. (REFER SPECIFICATION FOR ELECTRIC HOISTS BELOW)

i. **Gearing and Gear-boxes**

Straight and helical spur gearing in metric module shall be used for all motions. Worm gearing shall not be used. All gears shall be of hardened and tempered alloy steel with machine cut teeth. Hardness for pinion shall be 220 BHN and for gears it shall be 200 BHN. All gearings shall be enclosed in oil tight gear-boxes. Fabricated gear-boxes shall be stress relieved before machining.

j. **Bearings and Bearing Housing**

Ball and roller anti-friction bearings shall be used throughout unless otherwise specified. Anti-friction spherical roller bearings shall be provided for live axles of travel wheels. Housings shall be split on shaft centre line to permit removal of the shaft. The underside of the base of each bearing pedestal shall be machined and shall bear upon a machined surface.

k. **Couplings**

Flexible coupling shall be used between the LT motor and gear-box and between gear-box out put shaft and wheel shaft. In case of single motor central drive for LT motion, out put shaft of the gear-box shall be connected through solid flange couplings. Half-gearered couplings with floating shaft shall be provided between the wheel and the line shaft.

l. **Hook Blocks**
Hook blocks shall be of enclosed type leaving openings for ropes only so that ropes do not run off the sheaves. Standard swivelling shank hooks, mounted on thrust bearings shall be used unless otherwise specified.

m. Brakes

Electro-magnetic brakes shall be provided for each motion on the high speed pinion shaft of the gear-train.

n. Buffers

The crane shall be provided with rubber buffers on the four corners of the end-carriages unless otherwise specified. For electrically operated hoists, steel stops at all the four ends of the track beam shall be provided.

15-B.05 ELECTRICAL DETAILS (to be followed cl.no.15-A-02-06)

15-B.06 DOCUMENTATION

1. Drawings and documents to be submitted by the Tenderer with Tender

The tenderer shall submit adequate sets of following technical drawings & technical data/information with tender for cranes without which the tender shall be considered as incomplete & may not be considered for acceptance.

   a) General Arrangement drawings of cranes/hoists/attachment & signed copies of Clearance diagramme

Duly filled in questionnaire.

2. List of Drawing/Documents to be furnished by the Successful Tenderer for approval/reference

   a) General Arrangement drawings of cranes/hoists/attachment & signed copies of Clearance diagramme
   a) Quality assurance plan for inspection.
   b) Specification of oils and lubricants and other consumables and their quantity and frequency of change.
   c) Detailed layout plan and sections for power supply system. (Angle Bus bar/Shrouded Bus Bar/Festoon Cable etc.)
   d) DSL/Trolley line arrangement layout.

3. List of Drawings/Documents to be furnished alongwith equipment by the Successful Tenderer

   01. Requisite no. of sets of all GA drawings, complete assembly and sub assembly drawings of the equipment.
   02. Drawing of all equipment/component received from sub supplier.
   03. Engineering and design calculations.
   04. Test and warranty certificate for each item of equipment.
   05. Detailed erection schedule and manuals, assembly/erection drawings, erection sequence, special precautions to be followed during assembly/erection (these shall be despatched three months prior to FOT/FOR delivery).
06. Test reports and inspection reports.
07. Instruction manuals for testing and commissioning.
08. Operation, maintenance and safety manuals.
09. Requirement of special tools and tackles, if any, for subsequent maintenance.
10. Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions (two sets and one reproducible and/or two sets of catalogues).
11. List of spare parts with drawings, sketches, specifications and manufacturer’s catalogue (two sets and one reproducible and/or two sets of catalogues)
12. All other drawings and documents as stipulated in General Conditions of Contract.

15-B.07 QUESTIONNAIRE (SG EOT/US CRANE)

I/ Crane No. : 
ii/ Nos. off : 
iii/ Type of crane : 
iv/ Capacity (t) : 
v/ Span (m) : 
vi/ Duty class : 
vii/ Location : 
viii/ **Hoists** :

a) Speed with safe working load, m/min : 
b) No. of rope falls supporting the load and specification of rope : 
c) Lift of hook above floor, m : 
d) Drop of hook below floor, m : 
e) kW of motor at specified rating : 
f) RPM of motor : 
g) Make, type and size of brake : 

ix/ **Cross - travel** :

a) Speed with working load, m/min : 
b) Wheel base, mm : 
c) No. of wheels : 
d) kW of motor at specified speed : 
e) RPM of motor : 
f) Make, type and size of brake : 

x/ **Bridge** :

a) Speed with safe working load, m/min : 
b) Wheel base, mm : 
c) No. of wheel on each end-carriage : 
d) Diameter of wheel, mm : 
e) Maximum wheel load, kg : 
f) No. of motors : 
g) kW of motor at specified rating : 
h) RPM of motor : 
i) Make, type and size of brake : 

xi/ Power supply : 

xii/ Control voltage : 

xiii/ Made and type of control : 

xiv/ Total weight of crane, t : 

xv/ Total weight of hoist, t : 

xvi/ Break-up of crane weight, t :

a) Structural : 

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b) Mechanical:

c) Electrical:

xvii/ General arrangement drawing showing details as enumerated:

xviii/ List of deviations from the Purchaser’s Specification:
15-C ELECTRIC HOIST

15-C.01 The scope of work of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer's shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection testing & commissioning of Electric hoist of various capacity.

15-C.02 TECHNICAL SPECIFICATION

a) The hoist shall be designed in accordance with IS:3938-1983.

b) For outdoor hoists, motors, brakes & other equipment shall be covered to suit to outdoor operations.

c) All trailing cables shall be clamped with PVC or non-metallic clamps.

d) Defects in the materials like fractures, cracks, blowholes, or laminations are not allowed.

e) No cast iron parts shall be used except for electrical equipments and no wood or combustible material shall be used unless specifically mentioned otherwise.

f) All working parts requiring replacements or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

g) All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washer.

h) All parts of the hoist shall be thoroughly cleaned of all loose mill scales, rust or foreign matter & then painted as specified. All parts inaccessible after assembly shall be painted before assembly & assembled while paint is still wet.

i) All parts except motors, resistors, gears, thrustors, solenoids, etc. shall be de-rusted manually & painted as follows:

15-C.03 Mechanical details

01. Wheel & drive

The electric hoist shall run on two pairs of wheels, a pair of which shall be driven by motor through reduction gear. The wheels shall be of cast steel/forged steel, single flanged with taper / parallel treads to suit to monorail. The wheels shall be mounted on anti-friction bearings & shall be easily removable for repair & replacement. The wheel diameter shall be selected such that skidding does not take place even under unloaded condition.

02. Hoist mechanism

The hoist mechanism shall consist of a bottom block fitted with a standard forged swivel hook of the specified capacity, supported on 2 or 4 falls of wire rope. However, non-spinning type of wire rope shall be used for 2 falls rope arrangement. The wire rope shall be wound on a grooved drum which shall be sufficiently long to accommodate in one layer the length of rope requisite for the specified lift & in addition not fewer than two turns at each anchored end & one spare groove at the opposite end. The hoist drum shall be motor driven through gears enclosed in oil filled reduction gearbox.
03. Gearing

Straight & helical spur gearing shall be used for all motions. Worm & bevel gears shall not be used with specific permission from purchaser. Preferably all first reduction gears shall have single helical teeth. All gears shall be hardened & tempered alloy or carbon steel with machine out teeth. Surface hardening of teeth is not acceptable. All gears shall be enclosed in oil filled gear box except when not possible.

04. Couplings

Each motor shall be connected to its gear drive by a flexible coupling.

05. Lubrication

All gears & bearings shall be lubricated either by splash lubrication or by grease. If possible, all the lubricating points shall be grouped together in easily accessible positions.

06. Bearings

Ball & roller antifriction bearings of reputed make shall only be used, with minimum bearing life as per IS: 3938.

07. Brakes

D.C. Electromagnetic brake shall be provided for each motion, however in case of conical rotor motors manufacturer’s standard brake can be used.

08. The Electric hoists shall be inspected as per IS: 3938 - 1983 and as specified in GCC.

15-C.04 DOCUMENTATION

1. Drawings and documents to be submitted by the Tenderer with Tender

The tenderer shall submit adequate sets of following technical drawings & technical data/information with tender for cranes without which the tender shall be considered as incomplete & may not be considered for acceptance.

   a) General arrangement drawings of the Hoist with all technical parameters & details.
   b) Duly filled in questionnaire.

2. List of Drawing/ Documents to be furnished by the Successful Tenderer for approval / reference

   a) General arrangement drawing of equipment showing full details in plan and sections.
   b) Quality assurance plan for inspection.
   c) Specification of oils and lubricants and other consumables and their quantity and frequency of change (reference)
   d) Detailed layout plan and sections for power supply system.

3. List of Drawings/ Documents to be furnished along with equipment by the Successful Tenderer

   a) GA drawings, complete assembly and sub assembly drawings of the equipment.
   b) Engineering and design calculations.
c) Test and warranty certificate for each item of equipment.
d) Test reports and inspection reports.
e) Instruction manuals for testing and commissioning.
f) Operation, maintenance and safety manuals.
g) Requirement of special tools and tackles, if any, for subsequent maintenance.
h) All other drawings and documents as stipulated in General Conditions of Contract.

15-C.05 QUESTIONNAIRE (ELECTRIC HOIST)

01 General
Item number :
Location :
Capacity :
Duty classification :
Total weight of hoist :
Make :

02 Hoist
Speeds with safe working load :
Lifting height :
a) Above floor level :
b) Below floor level :
Wire ropes :
a) Type of construction :
b) Size :
c) Number of falls :
d) Factor of safety :
Rope drum :
a) Materials :
b) Diameter :
Drives :
a) Type & material of gear box :
b) Gear & pinion :
c) Material & hardness :
Motors :
a) Type & number :
b) Kw rating :
c) Synchronous speed :
d) Class of insulation :
e) Pull out torque :
f) Frame size :
Brakes :
a) Type :
b) Size :
c) Torque rating :
   ➢ Type & details of limit switches :
   ➢ Type of couplings :
   ➢ Type of bearings :
Lifting hook
a) Type : 

b) Material : 
   ‣ Type & details of control : 

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03 Trolley

   ➢ Speed with safe working load : 

Wheels

a) Numbers : 

b) Diameter : 

c) Material & hardness : 

d) Max. wheel load : 

e) Wheel base : 

Drive

a) Type & material of gear box : 

b) Gears & pinions : 

c) Material & hardness : 

d) Kw rating : 

e) Synchronous speed : 

f) Class of insulation : 

g) Pull out torque : 

i) Frame size : 

Brakes

a) Type : 

b) Size : 

c) Torque rating : 

Type & details of limit switches : 

Type of coupling : 

Type of bearings : 

Type & details of controls : 

04 Clearance diagram indicating the basic dimensions : 

05 Type & lubrication provided : 

06 Type & size of cables : 

07 Location & control details of hoist block power feeding arrangement : 

15-D  JIB CRANE

15-D.01  Scope of work

The Jib Crane shall be designed, manufactured, assembled and tested in accordance with IS: 807-1976, IS: 3177-1999, IS: 3938-1983 and other relevant codes and practices to be used in steel plants.

The crane shall conform to various safety codes as applicable.

All parts requiring replacement/inspection/lubrication shall be easily accessible.

Inspection & testing of the hoists shall be conducted as per relevant clause of IS: 3938-1983.

15-D.02  Design standard and General Details

01. The Crane Structure shall be designed in accordance with IS: 807-1976 for the jib column and jib arm of the crane. The details of the crane structure indicated in the Single Girder EOT/US Crane part of the TS shall be followed.

02. The components of electric hoist for the jib crane shall be designed, manufactured, assembled and tested in accordance with IS:3938-1983 and shall be of standard make. The details of the electric hoist indicated in the electric hoist part of the TS (Clause 15C.00) shall be followed.

03. The Structural steel work of the jib crane structure shall conform to IS; 2062-1992.

04. The boom of the jib crane shall be from either rolled steel section of fabricated type.

05. The design of the boom shall be such that the vertical deflection caused by the maximum rated load with the hoist at the maximum jib radius position on the boom, shall not exceed 1/250 of the boom length.

06. The column of the jib crane shall be of heavy duty steel tube or fabricated / lattice structure. Proper bearing housing block for housing bearing for supporting the boom shall be provided at the top.

07. The jib arm support bearing shall be of anti friction ball/ roller bearing.

08. Base plate of the column should be provided with drilling holes of appropriate sizes for fixing the jib crane on the foundation / support.

09. The foundation bolts will be so designed that 50 percent of the bolts provided will be able to take the full load of the jib crane and the turning moments.

10. The design of the column of the jib crane shall be such that overall deflection of the jib does not exceed 1/300 of (boom length, column height) when the jib crane is fully loaded.

11. The connection between the boom and the pillar shall be designed suitably to give proper end fixing to the boom and to ensure that the play between moving members is kept to the minimum.
12. All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and tested.

15-D.03 Documentation

Refer documentation for SG EOT /US crane mentioned above.

15-D.04 Questionnaire

Refer questionnaire for SG EOT /US crane mentioned above.
15-E MANUAL HOIST

15-E.01 The scope of work of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer’s shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection testing & commissioning of manual hoist with traveling trolley of various capacity.

15-E.02 Technical Specification of Manual Hoist with Traveling Trolley

- Ball and roller anti frictional bearing only shall be used.
- Swivelling type standard shank hook mounted on grease lubricated anti-friction thrust bearing shall be used.
- The Chain Pulley Block shall conform to class-I duty as per IS: 3832-1986.
- Load chain & operating chain shall be of calibrated type.
- Pulley used for the operating mechanism shall have suitable guards to prevent the operating chain from coming out.
- All the open gearing shall have suitable cover.

15-E.03 DOCUMENTATION

1. Drawings/ Documents to be submitted with the tender.

The Tenderer shall submit the following technical drawings & technical data/ information with tender for manual hoist with traveling trolley, without which the tender shall be considered as incomplete & may not be considered for acceptance.

a) Typical General arrangement drawings & catalogues of the hoist.

b) The questionnaire filled in.

2. Final drawings/documents to be furnished along with the equipment :

a) General Arrangement drawings and all data /catalogues.

b) Supply of report on shop tests and material test certificate.

c) Supply of all operating manual, maintenance schedule & lubrication chart.

15-E.04 Questionnaire

1. Equipment No. : 
2. Capacity : 
3. Quantity : 
4. Height of Lift : 
5. Class of Duty : 
6. Make : 
7. Min$^m$. Radius of Curvature
8. Max. Tractive effort (Kgs)
   • Hoist
   • Travel

9. Movement in ‘m’
   corresponding to operating chain movement of 30m.
   • Hoist
   • Travel

15.F CANTILEVER CRANE

The scope of work of the Tenderer shall consist of design, manufacture, inspection, assembly, painting, supply and transportation to site, testing & commissioning of Column/Pillar Mounted Cantilever Cranes as per technical parameters indicated in enclosed clearance diagrams.

15.F.01 TECHNICAL SPECIFICATION

i/ The cranes shall be designed, manufactured, assembled and tested in accordance with IS:15419-2004, 807-2006, IS:3177-999, IS:3938-1983 and other relevant codes and practices for the cranes to be used in steel plants, steel industry (IPSS) unless otherwise stated. IPSS (wherever applicable) shall also be followed.

ii/ The components of the hoist shall be designed, manufactured, assembled and tested in accordance with IS:3938-1983 and shall be of standard make.

iii/ All working parts requiring replacement or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structure.

iv/ All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and tested.

v/ For out-door cranes all electrical and mechanical components which are exposed to weather shall be completely covered or made weather proof. The covers shall be in segments to facilitate easy dismantling and assembly.

vi/ No cast iron parts shall be used except for electrical equipment and no wood or other combustible material shall be used unless specifically mentioned otherwise.

vii/ Where down shop leads are located below runway rails, guard shall be provided on the crane to prevent the hoist ropes from coming in contact with down shop leads.

viii/ All bolts except those with nyloc nuts shall be provided with grip lock nuts or spring washers.
ix/ All trailing cables shall be clamped with PVC or non-metallic clamps.

x/ Steel frames carrying machinery shall be machined to true surface.

xi/ All gears and bearings shall be lubricated by splash lubrication/grease as required. All greasing points shall be easily accessible.

xii/ Testing

A. At Manufacturer's Works

The supplier in the presence of the Consultant shall carry out following tests:

1. Visual check

The crane after assembly shall be visually checked for any defect in the workmanship.

2. Dimensional check

All dimensions of the crane shall be checked as per the approved general arrangement drawings. Diagonal measurement of the crane/hoist shall also be carried out in the shop before despatch to site. The dimension of the cranes after assembly shall be within the tolerances specified below:

a) Span over L.T. wheels : +3 mm
b) Diagonal on wheels : +2 mm
c) L.T wheel alignment : +1 mm
d) Tilt of wheel : 1 mm/1000 mm (Vertical & horizontal)
e) Over buffer length : +5 mm (Over buffer dimension on
Two sides shall be same)
f) Load test for hoist : As per IS:3938-1992/3177-1999
g) No load running test of the L.T. mechanism of the crane.

B. At Site

1. Visual check

a) The crane after erection shall be visually checked for any missing/damaged parts or defects in erection. These defects/missing parts shall be made good.

b) The crane after erection will have dimensions within the tolerances enumerated earlier.

c) Deflection test, insulation test, performance test and overload test:

These tests shall be done as enumerated in IS 3177-1999 and IS:15419-2004. However, there would be no permanent set in the structures after the removal of the 125% overload. The tolerance on the lowering speed may be +20% of the specified hoisting speed instead of +10% of hoisting speed specified in IS: 3177-1999.
d) The representative of supplier shall be present at site during testing and commissioning of the crane and any defect/deficiency pointed out by the Purchaser shall be made good by supplier free of cost.

15.F.02 Structural Design

15.F.02.01 Column/Pillar Mounted Cantilever Cranes

i/ The cranes shall be designed in accordance with IS: 807 for the column and arm of the crane.

ii/ The structural steel material for the crane structure shall confirm to IS: 2062-2006 and IS: 8500-1991.

iii/ The boom of the cranes shall be from section or fabricated type with rolled section or tubular sections.

iv/ The design of the boom shall be such that the vertical deflection caused by the maximum rated load with the hoist at maximum radius position on the boom, shall not exceed 1/250 of the boom length.

v/ The column of the crane shall be made of heavy duty steel tube or fabricated/ lattice structure to ensure minimum deflection at full load. Proper bearing housing block, for housing required bearing for supporting the boom, shall be provided at the top or at suitable locations.

vi/ The arm support bearing will be either anti-friction ball roller bearing (or bush type bearing) as per design/client’s requirement.

ix/ The design of column and boom of self supported cantilever crane shall be such that overall deflection of the crane does not exceed the limit of (boom length + Column height)/ 300 when the hoist along with load is at extreme boom radius.

x/ The connection between the boom and the pillar shall be designed suitably to give proper end fixing to the boom and to ensure that they play between moving member is kept to the minimum.

xi/ Match mark shall be provided on each part of the structure to facilitate erection and alignment of the crane at site.

15.F.02.02 Mechanical Equipment

I/ Design of Mechanisms

Each mechanism of the crane shall be modular in construction with built in facilities for easy dismantling and maintenance of each assembly as an independent unit.

ii/ Rope Drums

Fabricated rope drum shall be stress relieved before machining. For the cranes used in steel plants, the material of the rope drum shall be limited to C.S. / M.S. The rope drum shall preferably have left and right hand deep groove for low abrasion and true
vertical lift and shall be sufficiently long to accommodate in one layer the length of rope requisite for the specified lift & in addition not fewer than two turns at each anchored end & one spare groove at the opposite end.

iii/ **Wire Rope**

The wire ropes shall be regular right hand lay hemp cores as per IS:2266-2002. However, ropes working under water and in corrosive atmosphere shall be galvanized and shall have steel core. For rope arrangement with 2 falls, wire rope shall be of non-spinning type. For the cranes in steel plant, selection of wire rope shall be as per IPSS.

iv/ **Rope Guides**

Suitably designed rope guides with pressure ring/ rope tightener shall be provided for each lead of rope from the rope drum to prevent the rope from overriding, loosening or rope coming off the groove.

v) **Rope sheaves**

For cranes in steel plants, material shall be either CS/MS. Bottom block sheaves shall be provided with suitable guards to retain the rope in the sheave groove.

Equalizer sheave/ bar shall be arranged to turn and swivel to maintain rope alignment under all circumstances.

vi) **Wheels**

Single flange straight or taper tread type wheels shall be used for under slung type trolley motion. The side clearance between the runway beam flange and wheel shall be 3 to 4mm on either side. Wheels shall be of forged/ rolled/ cast steel with minimum hardness of 250 BHN.

vii/ **Slew Drive**

Motorized slew drive shall be provided for cantilever cranes. The speed at the tip of the jib boom should be restricted to 15 m/min. The brake shall be mounted on the input or extension shaft of gear box. In addition end stoppers are to be mounted on the pillar. Suitable limit switches shall be provided in order to restrict the angle of rotation of the jib.

viii/ **Hoist and Cross-Travel Drive**

In case of Cantilever crane with electric hoist, hoist and cross travel motions shall be combined in one block which shall be designed as per IS:3938-1983.

In case of cantilever crane with double Jib Arm, CT and hoist mechanism shall be through trolley/crab similar to DG EOT crane.

ix/ **Gearing and Gear-boxes**

Straight and helical spur gearing in metric module shall be used for all motions. Worm gearing shall not be used. All gears shall be of hardened and tempered alloy steel with machine cut teeth. Hardness for pinion shall be 220 BHN.
and for gears it shall be 200 BHN. All gearings shall be enclosed in oil tight gear-boxes. Fabricated gear-boxes shall be stress relieved before machining.

x/ **Bearings and Bearing Housing**

Ball and roller anti-friction bearings shall be used throughout unless otherwise specified. Anti-friction spherical roller bearings shall be provided for live axles of travel wheels. Housings shall be split on shaft centre line to permit removal of the shaft. The underside of the base of each bearing pedestal shall be machined and shall bear upon a machined surface. Due allowance shall be made for impact and side thrust while selection of bearings. Wherever necessary, spherical seating type separate thrust bearings of suitable dimensions shall be used. Life of ball & roller anti-friction bearings shall be calculated in accordance with manufacturer’s recommendations and based on equivalent running time. The bearings used shall be of reputed make only.

xi/ **Couplings**

Each motor shall be connected to its gear drive by a flexible coupling. All couplings shall be cast, wrought or from forged steel, tooth portion to be heat treated to hardened HB 241-280 and also shall be designed to suit the maximum torque that may be developed.

Alignment shall be such that solid couplings mate accurately. Flexible/ fluid couplings shall be initially aligned with the same accuracy as the solid couplings.

Flexible couplings of fail safe type shall be fitted between motor shaft and gearbox extension shaft of electric hoist.

xxii/ **Shaft and Keys**

Shaft and axle shall have ample strength and rigidity and adequate bearing surface. They shall be finished smoothly and shall be provided with fillets of as large a radius as possible and/or be suitably tapered. All shafts shall be made of suitable quality of steel as recommended in IS:3177 (cl.8.2.1). Keys, key ways and splines shall be either involute or straight sided and shall conform to the relevant Indian Standards. Keys shall be so fitted and secured that they cannot work loose in service.

xiii/ **Lubrication**

All gears & bearings shall be lubricated either by splash lubrication or by grease. If possible, all the lubricating points shall be grouped together in easily accessible positions.

xii/ **Hook Blocks**

Hook blocks shall be of enclosed type leaving openings for ropes only so that ropes do not run off the sheaves. Standard swiveling shank hooks, mounted on thrust bearings shall be used unless otherwise specified.
**Brakes**

Electro-magnetic brakes shall be provided for each motion on the high speed pinion shaft of the gear-train. Brakes shall be capable of bringing the fully loaded crane hoist safely to rest in shortest possible time with least possible shock and shall arrest the motion under all service condition. D.C. Spring for electro magnetic brakes shall be the compression type and shall not be stressed in excess of 80% of the torsional elastic limit of the material.

Wearing surface of all the brake drums shall be machined and shall be cylindrical, smooth and free from defects. Brake lining shall be effectively and permanently secured the brake shoe during the effective life of the lining. Wherever required DC Disc brakes may be used.

**Buffers**

The crane shall be provided with rubber buffers on the four corners (two in case of cantilever cranes) of the end-carriages unless otherwise specified. For electrically operated hoists, steel stops at all the four ends of the track beam shall be provided.

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**15.F.03 Electrical Details (to be followed cl.no.15-F-02-06)**

**15.F.04 DOCUMENTATION**

**15.F.04.01 Drawings and documents to be submitted by the tenderer with Tender**

The tenderer shall submit four sets of following technical drawings & technical data/information with tender for cranes without which the tender shall be considered as incomplete & may not be considered for acceptance.

1. General arrangement drawings of the cranes/ signed copies of the clearance diagram with the confirmation that all the dimensions shall be adhered to while preparing GA drawings.

2. Time bar chart of delivery showing break up of time required for raw material procurement, engineering, various shop activities, order placement for bought out items and their delivery to shop, assembly, testing, inspection and despatch.

3. Deviations from tender documents.

4. The questionnaire filled in.

**15.F.04.02 List of Drawing/ Documents to be furnished by the Successful Tenderer (Nos. of copies shall be as per GCC)**

The following drawing/documents to be submitted by the Successful Tenderer within 30 days of placement of order.

1. General arrangement drawing of equipment showing full details in plan and sections along with design calculations.
2. General arrangement drawing of hoist blocks/ trolleys.

3. Schematic control circuit diagrams for individual drives along with contactor sequence diagram and motor speed/ torque characteristics.

4. Motor power, DSL sizing, voltage drop and brake calculation.

5. Quality assurance plan for inspection.

6. Specification of oils and lubricants and other consumables and their quantity and frequency of change.

7. Cable schedule and inter connection diagrams.

8. Control schematic diagram.


10. Detail specification of motor indicating type, KW, rpm, no of starts/hr Duty, starting torque requirement, class of insulation, type of enclosure, frame size, etc.

11. Power requirement.

12. Detailed layout plan and sections for power supply system. (angle Bus bar/Shrouded Bus Bar/ Festoon Cable etc.)

15.F.04.03 List of Drawings/ Documents to be furnished alongwith equipment by the Successful Tenderer (Nos. of copies shall be as per GCC)

1. Requisite no. of sets of all GA drawings, complete assembly and sub assembly drawings of the equipment together with two copies of good quality polyester reproducible.

2. Drawing of all equipment/ component received from sub supplier together with two copies of reproducible.

3. Engineering and design calculations.

4. Test and warranty certificate for each item of equipment.

5. Detailed erection schedule and manuals, assembly/ erection drawings, erection sequence, special precautions to be followed during assembly/ erection (these shall be despatched three months prior to FOT/FOR delivery).

6. Test reports and inspection reports.

7. Instruction manuals for testing and commissioning.

8. Operation, maintenance and safety manuals.

9. Requirement of special tools and tackles, if any, for subsequent maintenance.
10. Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions (two sets and one reproducible and/or two sets of catalogues).

11. List of spare parts with drawings, sketches, specifications and manufacturer’s catalogue (two sets and one reproducible and/or two sets of catalogues)

12. All other drawings and documents as stipulated in General Conditions of Contract.

**QUESTIONNAIRE**

Annexure-1

(To be filled in for each crane and shall be submitted along with Tender)

B. For Cantilever Cranes

i. Type of Crane
ii. Capacity
iii. Operating Speed:
   a. Hoist
   b) Cross Travel
   c) Slew
iv) Jib outreach/radius:
v. Type of Hook
vi. Total height of lift
vii. Wire Rope
    Dia, Construction, core, tensile designation, Min. breaking strength, no. of falls, F.O.S, make etc.
viii. Type of Brakes
    a) Hoist
    b) Travel :
ix. Motor’s details (type, kW, Pole, %CDF, no. of start/Hr, Duty, POT, Insulation & enclosure class, qty, Make etc.)
    a) Hoist
    b) Travel
    c) Slew
x. Power supply
xi. Control voltage
xii. Made and type of control
xiii. Break-up of crane weight, t
    a) Structural
    b) Mechanical
    c) Electrical
16 ELEVATORS

16-A RACK & PINION TYPE ELEVATOR

16-A.01 Scope of Work

- The scope of work of the Tenderer shall consist of design, manufacture, inspection, assembly, and painting at manufacturer’s shop as well as at site after erection, supply and transportation to site, unloading and re-conservation at site, erection, testing & commissioning of Rack and Pinion Type Passenger Elevator for Chimney. The elevator shall be complete with electrical equipment and attachment as covered under this specification. The elevator shall be installed with chimney.

- The elevator shall be complete with car cage, guides with their support, drive system, drive base, cage and door system, battery operated emergency light, alarm bell, complete electric and control system, car and hoist way illumination system, buffers, switches etc. and other necessary fixtures and accessories whether mentioned in this specification or not but necessary for successful installation, operation and maintenance of the elevator.

- The elevator shall be complete in all aspects including structural, mechanical, electrical equipment and other accessories. Any other equipment not covered in the specification but essential for proper design and operation shall be included in the scope of supply / work.

- The scope of work of the tenderer shall also include the following:

  Obtaining statutory clearances from statutory authorities.

  The elevator shall be operating with or without attendant.

  Supply of necessary fixtures if any required for erecting the Rack & Pinion Elevator in position shall also be under tenderer’s scope of work.

  The scope of work shall stand supplemented by this specification, general specification on quality system, inspection and test of plant & equipment at manufacturer’s premises.

  Scope of work of the contractor shall also include the maintenance of the elevators by their own men, machine and materials including spares and consumables for a period of 12 months after successful commissioning of the elevator.

16-A.02 TECHNICAL SPECIFICATION

1. Mechanical details

   General – The elevators shall conform to the following stipulations, in general:

   a) The elevator shall be designed in accordance with applicable norms of IS: 14665-2000 (Part 1, 2 & 3) and IS14665-2001 (Part-4) and other relevant IS specifications and subject to any modifications and requirements specified herein after.

   b) The elevator shall be suitable for continuous 24 hours round-the-clock operation.
c) The Rack & Pinion type passenger elevator cage shall be fabricated with steel construction with floor made of chequered plate and of minimum 6 mm thick over plain and suitably braced to ensure rigidity.

d) The elevator cage shall be provided with manual operated horizontal sliding opening door. The cage doors shall be provided with glass panels. The elevator shall be suitable for operation in a dusty atmosphere of power plants. Cage roof shall also be provided.

e) The cage floor shall be covered with rubber sheet.

f) The elevator shall be of rectangular cross section enclosed on three sides. The drive machine shall preferably be located on top of elevator cage.

g) Necessary hand railing all around drive machine shall also be provided to a height of 1.2 m. The power supply to the drive machine shall be through fixed and flexible power cable using cable guiding devices located on the elevator cage and at regular intervals on the elevator way.

h) Necessary precaution shall be taken in designing the cage to avoid undue vibration or side movement of cage during operation.

i) Safety hooks shall be provided in cage to prevent the same from detaching from the mast.

j) The mast shall be in sections of rectangular tubular structure of adequate height to facilitate quick erection at site. The rack shall be bolted to the lattice/ truss type masts. The rack shall be aligned and fixed to the mass using dowels. The mast shall be firmly attached to the chimney wall using anchor bolts and adjustable wall ties.

k) The section of the mast shall be inter-linking section for coupling for various mast sections like square section to rectangular section. These sections shall be complete with racks. The mast tube shall be of heavy-duty type.

l) Adequate numbers of spring buffers shall be fitted under the elevator cage directly on the floor/ base frame with suitable concrete or steel foundation. Buffers shall be located symmetrically with reference to the vertical centre line of the cage frame within a tolerance of 50 mm. The stroke of the spring buffer for car shall be equal to or greater than 40 mm.

m) Spring buffer shall be capable of supporting, without being compressed solid, a static load equivalent of two times the weight of car and its rated load for car buffers.

n) The elevator drive mechanism shall essentially consists of a reversible electric disc brake motor, over speed governor (centrifugal brake), gear coupling, worm reduction gear unit, drive pinion and progressive type positive action safety device etc.

o) The brake mechanism shall be provided with suitable means for adjustment of brake torque and magnetic air gap. The mechanism shall be of the “spring reset type” and not “gravity operated counter weight type”.

p) The brake position shall be such that double shaft extension is provided so that the brake pulley is not the same as the coupling face.

q) The worm reducer with extended shaft and the drive pinion mounted on it shall be of adequate ratio and of heavy-duty type. The worm wheel should be of special phosphorus bronze / equivalent with centrifugal cast and the worm shaft of special nickel chrome steel /
equivalent and case hardened. The drive pinion and rack shall be made of forged carbon / alloy steel with adequate hardness for the service intended.

r) The drive pinions shall be firmly engaged to the rack by means of rollers, mounted on the antifriction bearings, at the back of the rack. The pressure exerted on the rack shall be adequate to ensure proper backlash between the rack and pinion.

s) Double locks shall be provided so that the cage door shall not open during movement of elevator.

t) Cams operated double limit switches shall be provided to ensure cage stops at all landing positions.

u) The pinion shall be connected with two separate automatic braking systems, which shall activate when there is power failure or the elevator exceeds its maximum speed.

v) The elevator cage shall be provided with necessary switches including emergency bell switch and floor indicator. It shall also be provided with overload alarm and protection.

w) All parts requiring replacement or inspections or lubrication shall be easily accessible without the need for dismantling of other parts / equipment.

x) Provision shall be kept for emergency exit on top of the car in the event of fire or any other emergency.

y) A selector switch and a set of push buttons shall be provided on the top above the ceiling of the car to operate the elevator locally for inspection and maintenance. The selector switch when set to position “Inspection” shall exclude control from other places and movement of the car in the desired direction shall be effected by the push buttons. For normal operation of the elevator, the selector switch shall be set to the position working. It shall be possible to operate the elevator only when the appropriate button is kept in pressed condition.

z) Provision shall be made to prevent the opening of any landing door when the car is passing that zone in response to a call from another landing.

16-A.03 Testing & Commissioning

The testing and commissioning of the elevators shall be done in presence of the representatives of the manufacturer and owner.

The elevator after erection shall be tested as follow:

- Load test with 100% and 110% of rated load as per IS: 14665 - 2000.
- A static load test with 125% of rated load as per IS: 14665 – 2000 to check that the brake will sustain the car.
- All other tests on electrical system as mentioned in IS: 14665 - 2000.
- Any other test felt necessary by Owner and supplier to ensure proper functioning and installation of the lift.
- Demonstration of the functioning of all safety provisions made available in the elevator.
16-A.04 Design construction and performance requirement.

01. Load:
The elevator shall be designed to lift the pay load in addition to weight of the car itself and other accessories.

02. Speed
The elevator shall travel at a speed of 40.0 m/min.

03. Size
The inside dimensions of the platform of the car (clear inside) shall be ~1200mm X 1200mm. The inside clear height of elevator shall be 2200mm.

04. Travel and landings
The lift car shall travel from the landing floor from reference elevation to top landing as specified in the technical parameters/data sheets. In between these two levels the car shall stop at every intermediate platform levels as specified.

05. Wire Rope
The car and counter weight shall be suspended by steel wire ropes. The number of wire ropes and size of wire rope shall be so chosen that highest factor of safety is achieved as per standard. Not less than three independent suspension ropes shall be used. The min\textsuperscript{m} diameter of rope shall be 12 mm and factor of safety 12.

06. Car

Car frame
- The lift car shall be carried in a complete frame of steel, which shall be sufficiently rigid to withstand the operation of the safety gear without permanent deformation to the car frame. The car structure shall be of steel with special painting or of stainless steel.
- At least four renewable guide shoes with renewable linings or set of roller guides shall be provided two at the top and two at the bottom of the car frame.

Car enclosure
- The car shall be enclosed on all sides by means of car body and door. The sides of the car shall be lined with heavy gauge stainless steel sheet panel properly braced and reinforced. The enclosure shall be flush on the inside and securely fastened to the platform. The car body floor shall be of M.S steel construction with chequered plate top. Side panels shall be of stainless steel grade 304 and roof of stainless steel over M.S frame.
- The car shall be equipped with handrails on three sides, fan with grills and suitable lighting with fittings. The light shall be left on during the whole time of use.
Necessary provisions shall be made for adequate ventilation of the car. Ventilation opening shall be provided in the enclosure roof as per requirement of IS: 14665-2000 (Part-3). A separate switch shall be provided in the car for the fan.

The enclosure of the lift car shall withstand a thrust of 35 kgs applied normally at any point, excepting any vision panel, without permanent deformation.

Car platform

- Car platform shall be constructed of structural steel shapes or securely fastened with steel flooring covered with rubber sheet / PVC tiles flooring. The platform shall be designed on the basis of rated loads evenly distributed. The car floor shall comprise a smooth non-slip surface.

- Since the car-leveling device will be used, subsequent aprons of sufficient depth shall be fitted to the car floor to ensure that no space is permitted between the threshold and the landing while the car is being leveled to a floor.

16-A.05 DOCUMENTATION

1. Information to be furnished by the Tenderer along with the tender:

The tenderer shall submit adequate sets of following technical drawings & technical data/information with tender for elevator without which the tender shall be considered as incomplete & may not be considered for acceptance.

a) General Arrangement of the Elevator indicating details.

b) Filled in questionnaire

2. List of drawings/documents to be furnished by the successful Tenderer for approval

a) General arrangement drawing of elevator showing full details in plan and sections.

b) Quality Assurance Plan for inspection.

c) Test and inspection certificate.

d) List of spares for 2 years normal maintenance.

3. List of drawings/documents to be submitted along with equipment by the successful Tenderer

j) GA drawings, complete assembly and sub assembly drawings of the equipment.

k) Drawings of all equipment/component received from sub supplier.

l) Test and warranty certificate for each item of equipment.

m) Test reports and inspection reports.

n) Instruction manuals for testing and commissioning.

o) Operation, maintenance and safety manuals.

p) List of spare parts with drawings, sketches, specifications and manufacturer's catalogue.

16-A.06 QUESTIONNAIRE (R&P TYPE PASSENGER ELEVATOR)

1) Name of manufacturer :

2) Nos. Off:

3) Type of elevator :

4) Capacity:
i  in Kg

ii  Number of passenger

5) Rated Speed (m/min)

6) Total travel (m)

7) Nos. of floor to be served

8) Floor levels

9) Size of elevator well / mast

10) Internal size of elevator car

11) Construction, design and finished car body work

12) Type of car door

13) Type of landing door

14) Type of landing & car door operation

15) Car entrance
   i  Number, size and type of doors.
   ii  Cars open in front.
   iii  Power or manual operation

16) Total Weight
   a) Mechanical component
   b) Structural item
   c) Others

17) Headroom required above top landing

18) Elevator operation

19) Method of control

20) Ambient temperature

21) Quantity of Motor

22) Power consumption

23) Leveling accuracy

24) Emergency power supply provided?

25) Intercommunication facility provided?

26) Brief description of control features and safety interlocks provided
16-B FREIGHT CUM PASSENGER ELEVATOR

16-B.01 Scope Of Work

- The scope of work of the Tenderer includes design, engineering, manufacture, assembly, inspection and testing, painting at manufacturer's shop as well as at site after erection, supply including dismantling for transportation, packing, forwarding, loading and transportation to site, receipt, unloading, storage and re-conservation at site, erection, testing and commissioning of the elevators at site.

- Obtaining statutory clearances from statutory authority.

- Scope of work of the contractor shall also include the maintenance of the elevators by their own men, machine and materials including spares and consumables for a period of 12 months after successful commissioning of the elevator.

16-B.02 TECHNICAL SPECIFICATION

1. Mechanical Details

   The elevators shall conform to the following stipulations, in general:

   The passenger and freight elevator shall preferably be designed, manufactured, erected tested and commissioned in accordance with the latest edition of IS: 14665 (Part-1 to 5). However, the elevator confirming to other reputed codes like BS, DIN, JIS or equivalent is also accepted. The components of the elevators shall be standardized to keep the number of spares to the minimum.

   a) The elevator will be installed inside the building to facilitate movement of man and material to various floor levels and shall operate from lower most level to top most level and will be located at identified location as shown in enclosed TS drawing.

   b) The elevator shall be equipped with all standard safety systems such as Bell and cranking in case of power failure, emergency rescue battery back-up, hand wheel connected with motor shaft for manual lowering of elevator to the nearest landing level in case of power failure, limit switches, indicators, over speed safety governor for car, emergency light fittings, etc.

   c) Lift shaft is to be provided with adequate lighting.

   d) The elevator shall be suitable for continuous 24 hours round-the-clock operation.

   e) The motor for the elevator shall be squirrel cage induction motor with speed resistance control/VVVF control for controlling the speed during starting and stopping at landings.

   f) Trouble-free performance of the elevator incorporating the operational, controlling and safety requirements, as specified, is to be guaranteed.

   g) A selector switch and a set of push buttons shall be provided on the top above the ceiling of the car to operate the elevator locally for inspection and maintenance. The selector switch when set to position "Inspection" shall
exclude control from other places and movement of the car in the desired
direction shall be effected by the push buttons.
For normal operation of the elevator, the selector switch shall be set to the
position working. It shall be possible to operate the elevator only when the
appropriate button is kept in pressed condition.

h) Provision shall be made for a safety gear, which shall operate in case of free fall
or over speeding of elevator car or counter weight in the descending direction.
This safety gear, while freezing the cabin mechanically to the guides, shall also
interrupt the control supply through a limit switch.

i) The particular landing door shall open only after the elevator car has stopped at
the landing. Additional provision shall be made for opening of the landing door
in case of emergency by means of a special key. The landing doors shall be so
designed that their closing and opening is not likely to injure a person.

j) Provision shall be made to prevent the opening of any landing door when the car
is passing that zone in response to a call from another landing.

k) At all the intermediate levels “Up” & “Down” call buttons with indicators shall be
provided. Car position indicator shall also be provided at all levels. At ground
level, “Up” call button with indicator & at top most level “Down” call button with
indicator shall be provided.

l) The circuit which supplies current to the motor shall not be included in any twin
or multi-core trailing cable used in connection with the control safety devices
/signaling equipment.

m) Safe access for maintenance and removal of all mechanical and electrical parts
shall be ensured, without additional scaffolding.

n) For other details relevant BS standards shall be followed.


01. Wire Rope

The car and counter weight shall be suspended by steel wire ropes. The
number of wire ropes and size of wire rope shall be so chosen that highest
factor of safety is achieved as per standard. Not less than three independent
suspension ropes shall be used. The minimum diameter of rope shall be 12mm
and factor of safety 12.

02. Car

Car frame

- Every lift car shall be carried in a complete frame of steel which shall
  be sufficiently rigid to withstand the operation of the safety gear without
  permanent deformation to the car frame. The car structure shall be of
  steel with special painting or of stainless steel.

- At least four renewable guide shoes with renewable linings or set of
  roller guides shall be provided, two at the top and two at the bottom of
  the car frame.
Car enclosure

- The car shall be enclosed on all sides by means of car body and door. The sides of the car shall be lined with heavy gauge stainless steel sheet plate properly braced and reinforced.
- The enclosure shall be flush on the inside and securely fastened to the platform. The car body floor shall be of M.S steel construction with chequered plate top. Side panels shall be of stainless steel grade 304 and roof of stainless steel over MS frame.
- The car shall be equipped with handrails on three sides, fan with grills and suitable lighting with fittings. The light shall be left on during the whole time of use.
- Necessary provisions shall be made for adequate ventilation of the car. Ventilation opening shall be provided in the enclosure roof as per requirement of IS: 14665 (Part 3/Sec 1 & 2)-2000. A separate switch shall be provided in the car for the fan.
- The enclosure of the lift car shall withstand a thrust of 35 kgs applied normally at any point, excepting any vision panel, without permanent deformation.

Car platform

- Car platform shall be constructed of structural steel shapes or securely fastened with steel flooring covered with PVC tiles flooring. The platform shall be designed on the basis of rated loads evenly distributed. The car floor shall comprise a smooth non-slip surface.
- Since the car leveling device will be used, subsequent aprons of sufficient depth shall be fitted to the car floor to ensure that no space is permitted between the threshold and the landing while the car is being leveled to a floor.

Car roof

- Car roof shall be covered with sheet metal to prevent dripping of lubricants from ropes-sheave bearings. The top flooring shall be of steel with decorative false ceiling. A three pin plug socket with a switch for head lamp shall be fitted on the top of the car for use during maintenance. The roof shall be strong enough to support at least two persons.
- Provision for slow speed (1/2 of rated speed) operation from car top in up and down directions in independent mode shall be made to facilitate maintenance of devices in the hoist way. Necessary fittings shall be provided for this purpose.
- Difference in levels of the car floor and landing shall not exceed the figures indicated in IS 14665 (Para 3/Sec 1 & 2)-2000 under heading “Leveling Accuracy”.
- Suitable lubrication system shall be provided for guide rails as well as for other items.

Car Door

- The elevator car shall be provided with collapsible type doors.
- The door of elevator shall open at all the platform levels.
- Car door shall have a clear opening of 1800 mm wide x 2200 mm high. The door operation shall be manual.

**Hoist Way Door**

- Horizontally collapsible type doors having a clear opening of 1800 mm wide x 2200 mm high shall be provided at each of the landing for elevator door

**Door Hangers & Tracks**

- Hangers and tracks for car door and each having a clear hoist way door shall be provided. Suitable material shall be used to minimize the noise. Ball bearing rollers or equivalent arrangement shall be provided to take upward thrust of the doors. Suitable devices shall be provided for transmitting from one door panel to the other.
- All required material for landing entrance e.g. extruded aluminum or equipment sills, struct angles, headers etc. shall be provided.

**Door operation for car door and hoist way doors**

- The doors operations shall be manual. The necessary door cushioning device shall be provided.
- Necessary safety devices shall be provided to prevent the movement of the car until the car door and hoist way doors are closed properly.

03. Car Self-Leveling Device

The elevator shall be equipped with automatic self-levelling devices to bring the car to the floor landings. These self levelling shall be correct for over travel or under-travel and rope stretch.

04. Control and operation

The elevator control i.e. the system governing starting or stopping the elevator machine, determine the direction of the travel, regulating the rate of travel, regulating the rate of acceleration and deceleration and controlling running speed of the moving member shall be through 3 phase two speed squirrel cage induction motor. The AC drive motor for the elevator shall be accelerate or decelerate the elevator according to requirement. Reversal in direction of movement of the elevator shall be achieved by reversing the motor 3phase supply.

The operation of the elevator i.e. method of actuating the control shall be “Selective Collective Automatic Operation” as per clause 3.41.3 of IS 14665 (Part2/Sec1) : 2000 with and without attendant. All accessories required for the “collective operation as outlined therein, namely selector and its driving shall be furnished complete.

The controller shall be preferably microprocessor based.

05. Car Position Indicator in Car
A signal indication shall be provided by the appropriate numeral (which shall be floor no./level of respective floor) being illuminated when the car is passing the corresponding floor. The indication shall remain illuminated when the car is stopped at a floor. Up & Down direction jewel lights shall also be provided. The car position indicators are needed to be provided at all landings.

Provision to indicate lift capacity in Kg as well as in terms of person, shall be made available in the car. Other signals like “over load” “Lift is under maintenance” etc. shall also be provided.

06. Push Button Station and Call-Registered Tell-tale Lights at Hoist way
A single “Up” and “Down” push button at terminal landings and “Up” “Down” each push intermediate landing including call register light for each push button shall be provided. These shall remain illuminated till the call is answered.

07. Emergency Exit
The elevator car shall be provided with an emergency exit of adequate dimension.

08. Terminal Buffers
The terminal buffers shall be provided for stopping the car and the counter weight at the extreme ends of travel. All structural steel members required to install the buffers shall be supplied by the lift supplier.

09. Counter-Weights and Counter-weight Frames
Counter weight sections shall be mounted on structural metal frames so designed to retain the weights securely in its place.

Counter –weight frame shall be guided on each guide rail by upper and lower guiding members attached to the frame

A substantial metal counter- guard of required length shall be provided at the bottom of the hoist way.

A compensating chain of adequate strength connecting car bottom and counter weight frame shall be provided for balancing the car and counter- weight while running with minimum load condition.

10. Guides for Car and Counter-weight
Car and counter- weight guides shall be of rigid steel and shall be continuous throughout the entire length and shall be provided with adequate steel bracings and stiffeners. Guide for both car and counter weight shall meet the requirement of IS: 4666-1980. The necessary lubrication device for guide rail shall be provided.

11. Terminal Limit Switches and Final Limit Switches
Terminal limit switches for normal operation shall be provided to slow -down and stop the car automatically at terminal landings and final limit switches shall be provided to automatically cut off the power and apply the brake, when the car travel beyond the terminal landing.
3. The elevator after erection shall be tested as follow:
   a) Load test with 100% and 110% of rated load as per IS: 14665 - 2000.
   b) A static load test with 125% of rated load as per IS: 14665 – 2000 to check that the brake will sustain the car.
   c) All other tests on electrical system as mentioned in IS: 14665 - 2000.
   d) Any other test felt necessary by Owner and supplier to ensure proper functioning and installation of the lift.
   e) Demonstration of the functioning of all safety provisions made available in the elevator.

The contractor shall arrange for weights, slings, wire ropes, stop watches and other necessary equipment/ instrument to carry out the test.

16-B.03 DOCUMENTATION

1. Information to be furnished by the Tenderer along with the tender:

The tenderer shall submit adequate sets of following technical drawings & technical data/ information with tender for elevator without which the tender shall be considered as incomplete & may not be considered for acceptance.

   a) General Arrangement of the Elevator indicating load data, details of various openings in machine room floor as well as lift well shaft, buffers etc.
   b) Filled in questionnaire
   c) List of commissioning spare,
   d) List of spares for two (2) years normal operation and maintenance
   e) List of insurance spare for each crane
   f) List of special/ maintenance tools & tackles.

2. List of drawings/ documents to be furnished by the successful Tenderer for approval

   a) General arrangement drawing of elevator showing full details in plan and sections.
   b) Quality Assurance Plan for inspection.
   c) Test and inspection certificate.
   d) List of spares for 2 years normal maintenance.
   e) List of insurance spare for each crane
   f) List of special/ maintenance tools & tackles.

3. List of drawings/documents to be submitted along with equipment by the successful Tenderer

   a) GA drawings, complete assembly and sub assembly drawings of the equipment.
   b) Drawings of all equipment/component received from sub supplier.
   c) Test and warranty certificate for each item of equipment.
   d) Test reports and inspection reports.
   e) Instruction manuals for testing and commissioning.
   f) Operation, maintenance and safety manuals.
   g) Requirement of special tools and tackles, if any, for subsequent maintenance.

16-B.04 QUESTIONNAIRE

01. Name of manufacturer : 
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<th>Description</th>
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<tr>
<td>02</td>
<td>Nos. Off</td>
</tr>
<tr>
<td>03</td>
<td>Type of elevator</td>
</tr>
<tr>
<td>04</td>
<td>Capacity,</td>
</tr>
<tr>
<td></td>
<td>i. in Kg</td>
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<tr>
<td></td>
<td>ii. Number of passenger</td>
</tr>
<tr>
<td>05</td>
<td>Rated Speed (m/min)</td>
</tr>
<tr>
<td>06</td>
<td>Total travel (m)</td>
</tr>
<tr>
<td>07</td>
<td>Nos. of floor to be served</td>
</tr>
<tr>
<td>08</td>
<td>Floor levels</td>
</tr>
<tr>
<td>09</td>
<td>Size of elevator well / mast</td>
</tr>
<tr>
<td>10</td>
<td>Internal size of elevator car</td>
</tr>
<tr>
<td>11</td>
<td>Construction, design and finished car body work</td>
</tr>
<tr>
<td>12</td>
<td>Type of car door</td>
</tr>
<tr>
<td>13</td>
<td>Type of landing door</td>
</tr>
<tr>
<td>14</td>
<td>Type of landing &amp; car door operation</td>
</tr>
<tr>
<td>15</td>
<td>Car entrance</td>
</tr>
<tr>
<td></td>
<td>i. Number, size and type of doors</td>
</tr>
<tr>
<td></td>
<td>ii. Cars open in front</td>
</tr>
<tr>
<td></td>
<td>iii. Power or manual operation</td>
</tr>
<tr>
<td>16</td>
<td>Total Weight</td>
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<tr>
<td></td>
<td>i. Mechanical component</td>
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<td></td>
<td>ii. Structural item</td>
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<td></td>
<td>iii. Others</td>
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<tr>
<td>17</td>
<td>Headroom required above top landing</td>
</tr>
<tr>
<td>18</td>
<td>Elevator operation</td>
</tr>
<tr>
<td>19</td>
<td>Method of control</td>
</tr>
<tr>
<td>20</td>
<td>Ambient temperature</td>
</tr>
<tr>
<td>21</td>
<td>Quantity of Motor</td>
</tr>
<tr>
<td>22</td>
<td>Power consumption</td>
</tr>
<tr>
<td>23</td>
<td>Leveling accuracy</td>
</tr>
<tr>
<td>24</td>
<td>Emergency power supply provided?</td>
</tr>
<tr>
<td>25</td>
<td>Intercommunication facility provided?</td>
</tr>
<tr>
<td>26</td>
<td>Electric power supply</td>
</tr>
<tr>
<td></td>
<td>i. Power Voltage (AC)</td>
</tr>
<tr>
<td></td>
<td>ii. Phase</td>
</tr>
<tr>
<td></td>
<td>iii. Cycles</td>
</tr>
<tr>
<td></td>
<td>iv. Wire system</td>
</tr>
<tr>
<td></td>
<td>v. Control voltage (DC)</td>
</tr>
<tr>
<td>27</td>
<td>Motor Details</td>
</tr>
<tr>
<td></td>
<td>i. Make</td>
</tr>
<tr>
<td></td>
<td>ii. Kw rating</td>
</tr>
<tr>
<td></td>
<td>iii. Frame size</td>
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<td></td>
<td>iv. Speed</td>
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<td></td>
<td>v. Duty cycle</td>
</tr>
<tr>
<td></td>
<td>vi. FL amperes</td>
</tr>
<tr>
<td></td>
<td>vii. Class of insulation</td>
</tr>
<tr>
<td></td>
<td>viii. No. of permissible starts per hour</td>
</tr>
</tbody>
</table>
17 TRANSFER CARS

17.01 SCOPE OF WORK

The scope of work of the Tenderer includes design, engineering, manufacturing, assembly, shop testing, painting, supply, transportation to site, unloading & storage, erection, testing and commissioning of Transfer cars complete with mechanical and electrical components.

01 The supplier shall ensure that the transfer car is manufactured as per the tolerances specified below:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Track gauge</td>
<td>± 3 mm</td>
</tr>
<tr>
<td>02</td>
<td>Diagonal of wheels</td>
<td>± 3 mm</td>
</tr>
<tr>
<td>03</td>
<td>Travel wheel alignment</td>
<td>± 1 mm</td>
</tr>
<tr>
<td>04</td>
<td>Tilt of wheels or balancer axle</td>
<td>± 1 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000 mm (horz. &amp; vert.)</td>
</tr>
<tr>
<td>05</td>
<td>Wheel base</td>
<td>± 3 mm</td>
</tr>
<tr>
<td>06</td>
<td>Travel speed at full notch with rated load, voltage and frequency shall be + 10% and – 5 % of specified speed.</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>All the axles with wheels shall be parallel to each other. Permissible deviation from parallelism shall not be more than 1 mm for every 1000 mm length.</td>
<td></td>
</tr>
</tbody>
</table>

No load test:

The transfer car shall be run in both the directions at maximum speed with no load. During this period, the speed and noise shall be checked. The bearing lubrication system shall also be checked for proper operation. At the end of this test, no part shall be excessively heated.

Speed test:

a. Travel motion of the transfer car shall be tested in both directions with rated load on all the notches and the speeds shall be attained at various notches as per approved speed-torque curve of the transfer car within the tolerance limits indicated under clause 03.10.06. The absorbed power as well as the speed shall be recorded and compared with guaranteed values. At the end of these tests no parts shall be excessively heated.

b. Travel motion of the car shall be tested with 25% over-load in which case the specified speeds need not be attained but the car shall show itself capable of dealing with the overload without difficulty.

Brake Test

The travel brakes shall be capable of arresting the motion within a distance in meters equal to 10% of speed in metres/minutes when travelling with rated load at rated speed, provided there is no skidding.
17.02 TECHNICAL SPECIFICATION

- GENERAL
  
a) The transfer car shall be designed, manufactured and tested in accordance with the relevant clauses of IS: 3177-1999. The standards referred there in and subject to any modifications and requirements specified in this specification.
  
b) The transfer car components shall be standardised to keep the number of spares minimum.
  
c) All parts requiring replacement or inspection or lubrication shall be easily accessible without the need for dismantling of other equipment or structures. All electrical cables shall be so laid that they are not liable to be damaged and can be easily inspected and maintained.
  
d) For welded construction such as that of main frames, gear boxes and other load bearing members, steel shall conform to IS: 2062-1992.

For welding these members low hydrogen electrodes shall be used as per IS 81-1991 grade E8 –542 -C-83H.

- STRUCTURAL DETAILS

Transfer car structures shall be designed in accordance with IS: 807-1990 taking the following additions/deviations into account.

  a) Black bolts shall not be used in the main structures of the transfer car.
  
b) Bolts used in shear shall be fitted into reamed holes.
  
c) Transverse fillet welding on load carrying members shall be avoided.
  
d) All butt welds on structural members subject to tensile stress shall be X-rayed.
  
e) Minimum thickness of chequered plates for platforms shall be 6 mm over plain for indoor transfer cars and 8 mm over plain for outdoor transfer cars. Chequered plates shall not be considered for strength calculations of load carrying members. Chequered plates shall be supported on a frame of beams adequately designed to take the rated load anywhere on the transfer car platform.
  
f) The under frame shall be fitted with substantial safety stops to prevent the transfer car from falling more than 25 mm in the event of breakage of track wheel, bogie or axle. These safety stops shall not interfere with the removal of the wheels.
  
g) Suitable jacking pads at a height of 300 mm from rail top shall be provided on under frames for jacking up the transfer car when changing track wheels. Jacking pads shall not interfere with the replacement of track wheels.
  
h) Main frame shall be fabricated in one piece unless there are transport limitations. Connection between the two parts of the frame shall be done by machined bolts or rivets.
i) All the mechanical and electrical equipment shall be placed below the top plates.

j) The maximum settlement of the platform under rated load shall not exceed 2-3 mm limited to span/1000.

k) Chequered plate steps suitably welded at convenient location on either side of the transfer car shall be provided for climbing up on the platform wherever necessary.

**Drive Suspension Frame**

a) All the driving mechanism such as motor, brake, gear box etc. shall be mounted on a rigid rolled section steel frame and suspended below the under frame with one end resting on the drive axle on anti-friction bearing, while the other end shall be elastically fastened to the under frame through helical compression springs. Drive Mechanism shall be protected from heat by providing heat shield on heat exposed area.

b) Clearance between ground and bottom most portion of the car shall not be less than 100 mm.

• **MECHANICAL DETAILS**

a) **Wheels**

- Solid wheels of forged, rolled or cast steel conforming to 55C8 of IS: 1570 - 1961 shall be used.

- Wheels shall be heat treated to have a hardness of BHN 300 to 350 on the rolling surface and flanges to a depth of not less than 10 mm with a smooth pass to the non-hardened zone.

b) **Axles**

Axle shall be made of class 4 steel to BE: 1875-1992.

c) **Axle Box Assembly**

The material of axle box casting shall conform to steel as per IS: 1030-1989 grade-1.

Spring seats, wherever required, shall be finished by machining.

d) **Springs**

All helical compression springs shall be designed in accordance with IS: 7906-1976 Part-1.

Spring ends shall be finished square with respect to its axis.

The spring shall be designed on the basis of virtually infinite life i.e. to withstand ten million load cycles or more without failure.
e) **Axle Box Frame**

Axle box frame of cast steel or fabricated steel construction shall be stress relieved and accurately machined. The parallelism between the faceplate and their perpendicularity with the top surface shall be closely maintained.

f) **Buffers**

Spring loaded or other better type buffers shall be fitted on the four corners of the transfer car for ensuring soft dashing of transfer car against stop.

Buffers shall be rigidly bolted in place, preferably along the centre line of transfer car track such that the bolts are not in direct shear.

Buffers shall be designed to absorb the kinetic energy released at 50% of the full load rated travelling speed, the average rate of deceleration not exceeding 4.8m/sec\(^2\) at 40% of the rated travelling speed.

Buffers shall have a contact surface of not less than 125mm in diameter and mounted so as to provide 100mm clearance between the fixed structures and car outreach when buffers of transfer cars are fully compressed.

g) **Drive mounted on transfer car**

For travel motion central drive shall be used. It shall be mounted as close as practicable to be centre of the car.

Drive shaft coupling shall be as near to the bearings as possible.

All parts of the travel drive shall be easily accessible for inspection, maintenance and removal from topside of platforms.

h) **Gearing**

Straight and helical spur gearing shall be used. Worm and bevel gears shall not be used. Surface hardness for pinion shall be 255 to 300 BHN and for gear it shall be 217 to 255 BHN. Difference in hardness of pinion and gear shall not be less than 20 BHN.

i) **Gear Box**

All gear shafts shall be supported in anti-friction bearings.

In gearboxes splash or automatic lubrication systems shall be used.

The gearbox shall be fabricated of cast steel. Fabricated gearbox shall be made of minimum 8-mm thick steel plate and shall be stress relieved.

Covers shall be split horizontally at each shaft centre line and fastened and arranged so that the top half can be removed for inspection and repair without disturbing the bottom half. Vertical gearbox may be provided with T-splits.

Directly above the mesh line of teeth, there shall be hand-hole with oil tight bolted covers.

The gearboxes shall be provided with breather vents, oil level indicator, dipsticks and easily accessible drain plugs.
Radial clearance between the gear box inner surface and the outside diameter of the gears shall be at least 1.25 times the depth of the largest gear tooth inside the gear box or 20 mm whichever is higher. The facial or side clearance between the inner surface of the gearbox and the face of the gear or pinion shall be at least 20 mm.

Gearbox shall be mounted on machined surfaces and shall have machined feet. Shims shall not be used.

j) **Bearings**

Only anti friction bearings shall be used.
Rated life of anti-friction bearings shall not be less than 40,000 hours.

k) **Couplings**

Motor shaft shall be connected to gear box input extension shaft through flexible gear couplings with crowned teeth. Gear coupling shall also be provided between gearbox and axle wheels if required.

All couplings shall be of forged steel and shall be designed to suit the maximum torque that can be developed.

Hardness of gear coupling casing shall be more than 340 BHN and that of toothed bush shall be more that 340 BHN. Bolt connection of couplings shall be easily accessible for inspection and tightening.

l) **Brakes**

Double shoe brake shall be provided for the drive of the transfer car and shall be mounted on the input pinion shaft of the gearbox. The brake shoe shall be of hinged type.

Brake drum shall be forged or of cast steel and shall be completely machined and dynamically balanced. Diameter of the brake drum shall be selected from preferred number series. Width of the brake drum shall be 10 mm more than the width of the brake shoes of each size. Hardness of the brake drum shall be 300 to 350 BHN.

Braking against travelling shall be capable of arresting the mote within a distance in metres equal to 10% of speed in meters /minute when travelling with rated load and speed, provided there is no skidding.

Adequate means shall be provided on outdoor transfer car for securely anchoring the same to the rail when not in use. Co-efficient of reserve of the holding force shall not be less than 2 considering maximum wind pressure.

In case of power failure there shall be automatic braking of the transfer car.

Brake shoes shall be of cast or forged steel.

m) **Shafting**

Shafts and axles shall also be checked for endurance and strength. In proportioning shafts, allowance shall be made for keyways and splines.
Changed of section in shafts shall be made with due allowance for stress concentration.

**n). Lubrication**

Grouped grease lubrication system for bearings shall be provided for transfer cars. Minimum internal diameter of grease pipe shall be 6mm. The pipe shall be securely fixed and protected from damage and assessable throughout.

Effective protection shall be provided to prevent ingress of dust on the lubricant and such protection shall also be weather proof on outdoor transfer car.

### 17.03 DOCUMENTATION

1. **Information to be furnished by the Tenderer along with the tender:**

   The tenderer shall submit adequate sets of following technical drawings & technical data/ information with tender for elevator without which the tender shall be considered as incomplete & may not be considered for acceptance.

   a) General Arrangement of the Transfer car indicating load data, details of various openings in machine room floor as well as lift well shaft, buffers etc.
   b) Filled in questionnaire
   c) List of commissioning spare
   d) List of spares for two (2) years normal operation and maintenance
   e) List of insurance spare for each crane
   f) List of special/ maintenance tools & tackles.
   g) List of Preferred Makes.

2. **List of drawings/ documents to be furnished by the successful Tenderer for approval**

   a) General arrangement drawing of Transfer car showing full details in plan and sections.
   b) Quality Assurance Plan for inspection.
   c) Detail specification of motor indicating type, KW, rpm, starting torque requirement, class of insulation, type of enclosure, frame size etc.
   d) Power requirement, details of motors, control scheme.
   e) Test and inspection certificate.
   f) List of spares for 2 years normal maintenance.
   g) Ordering specification for operating consumables / supplies.

3. **List of drawings/documents to be submitted along with equipment by the successful Tenderer**

   a) GA drawings, complete assembly and sub assembly drawings of the equipment.
   b) Drawings of all equipment/component received from sub supplier.
   c) Test and warranty certificate for each item of equipment.
   d) Test reports and inspection reports.
   e) Instruction manuals for testing and commissioning.
   f) Operation, maintenance and safety manuals.
   g) Requirement of special tools and tackles, if any, for subsequent maintenance.
17.04 QUESTIONNAIRE (TRANSFER CAR)

1. Load carrying capacity  :
2. Track gauge  :
3. Platform size (length X width)  :
4. Maximum side over hang  :
5. Top of platform from rail top  :
6. Maximum deflection of platform under Maximum working load  :
7. Total length of travel  :

01. Weights

1. Total weight of the transfer car (t)  :
2. Break up of weight
   a) Electrical  :
   b) Mechanical  :
   c) Structural  :
3. Weight of the heaviest part/assembly to be handled by the maintenance tackle  :

02. Parameters

1. Travelling speed (m/min) with maximum working load  :
2. No. of travel wheels  :
3. Wheel spacing  :
4. Wheel base  :
5. Diameter of wheel  :
6. Maximum & minimum wheel load with or without impact  :
7. Over buffer dimension  :

03. Wheels

1. Type of construction  :
2. Material of construction  :
3. Hardness  :

04. Gears and gear Box.

1. Make  :
2. Type  :
3. Material of construction for gear box  :
4. Material of construction for gear and pinion  :
5. Hardness of gear and pinion  :
6. Total reduction ratio  :
7. Total no. of reduction  :

06. Track rail size  :

07. Couplings

1. Make and type of couplings between
   a) Motor and gear box  :
   b) Gear box and shaft  :
   c) End shaft and axle  :

08. Make and type of limit switches  :
09. Make and type of bearings

10. Motors detail
   a) Type, make and frame size :
   b) kW rating at 40% & 60% CDF and ambient temp. :
   c) Motor rpm :
   d) No. of start/ hr :
   e) Class of insulation :
   f) Derating factor considering for ambient temp. :
   g) Calculated motor power :
   h) Frame size kW at specified duty :

11. Brake
   a) Make, type and size :
   b) Minimum braking torque as per catalogue :
   c) Surface hardness & material of brake drum :

12. Make and type of other electrical equipment
    Such as panels, contactors, etc. :

13. Wiring, trade name and class of insulation :

14. Cable reeling drum
   a) Type and make :
   b) Diameter :
   c) Cable size, type, makes & totals length :
   d) System of cable drum actuation :
18 FORK LIFT TRUCK (ELECTRICALLY OPERATED)

18.01 SCOPE OF WORK

The scope of work of the Tenderer shall consist of design, engineering, assembly, shop testing, painting, supply, testing and commissioning at site of Fork Lift Trucks complete with accessories and attachments as covered under this specification and attached equipment data sheet read along with GCC.

18.02 TECHNICAL SPECIFICATION

1. Design Standards and General Details

   a) The fork lift truck to be supplied under this specification shall be complete with all attachments, auxiliaries and accessories which are not specifically mentioned in the specification but are required to make equipment complete in all respects to fulfill the requirements of the prescribed duties, guaranteed performance and safe operation.

   b) The unit offered shall be new, unused and best of its kind. The unit shall also conform to the latest edition of the applicable Indian Standards and Regulation. Wherever the unit offered is not in accordance with the relevant Indian Standards and Regulations, the copies of the Standards to which the equipment conforms shall be submitted along with the proposal. Each unit shall have a printed sketch showing the load capacity at different load centres for safe operation.

   c) In case, due to standardisation of the products by the Manufacturer, the Tenderer is not able to quote for the exact specified capacity, he may quote for the next higher standard capacity. The unit offered shall be able to meet all the requirements of its specified duty. It would be preferred that the Tenderer shall quote for the equipment strictly conforming to the “Technical Specification and Equipment Details.” In case the unit offered has modifications and deviations, then the details of such modifications and deviations shall be clearly indicated. The reasons for such deviations shall also be clearly stated.

   d) All surfaces and parts except gears, bearings, etc. shall be properly cleaned / sand blasted/ chemically treated to remove all loose mill scale, rust, mud, foreign materials and then suitable corrosion resistance coating shall be applied to make the equipment fit for indoor /outdoor services in tropical weather conditions.

   e) The equipment shall be applied with two coats of final paint of approved quality and colour before despatch from the works.

   f) The equipment shall have sufficient lubrication arrangement so that bearing and other parts do not get unusually heated in course of operation. Sufficient lubrication points shall be provided wherever necessary and all such points shall be easily accessible. The Tenderer shall specify the lubricants and also the quantity required for six months period along with tender.

2. Mechanical Details

   a) The fork lift truck shall meet the stability requirements as per IS:4357-1957 (Reaffirmed -1990) for rated load capacities. The values of stability factor shall be as per IS:5040-
b) Brakes shall be hydraulic power assisted.

c) Mechanical hand brake for parking shall be provided.

d) Tilt and lift & auxiliary functions of the fork lift truck shall be hydraulically operated.

e) Operator’s seat shall be of cushioned and adjustable type. Driver’s overhead guard & load back rest shall also be provided.

f) A rigid towing attachment complete with pin or hook shall be provided at the rear of the truck.

g) All hydraulic hose pipes shall be suitably protected from damage during operation.

h) Suitable check valves shall be provided to ensure safety & control the lowering speed in case of loss of hydraulic pressures.

3. Electrical Details

a) The drive motor shall be designed and installed to meet the service conditions of battery operated fork lift trucks. It shall be suitable for operation from 48/36 V battery and shall be supplied completely wired up with the battery, control and protective equipment as well as indicating instruments mounted on the dash board.

b) The motor shall be series wound traction type. The rating shall be adequate for normal service condition as well as for driving the truck up a gradient as specified. The motor shall be minimum of class "F" insulation.

c) Replaceable covers for easy inspection, replacement and adjustment of carbon brushes shall be furnished.

d) The terminals of the motor shall be mounted on a terminating plate and all leads brought and terminated thereto. For repair and maintenance, it shall be possible to disconnect the motor from its terminals and take the motor out without disturbing any other ancillary equipment.

e) The motor shall be mounted on resilient pads suitable for the service conditions.

f) Dash board shall be equipped with the following:

   a) Battery discharge indicator / ammeter.
   b) Instrument pannel lights.
   c) Switches for lights.
   d) Key type starting switch.
   e) Any other instruments, switches, as necessary.

   g) The drive controller shall be suitable for speed variation in number of steps both in forward and reverse direction of movements.

   h) Head lights and tail lights suitable for night operation shall be provided.

   i) Electric or equivalent horn shall be provided. A bulb horn shall also be provided.
j) The fork lift truck shall be powered by a rechargeable electric storage battery of lead acid type and of reputed make.

k) The battery shall be used to supply power to the electrical drive motor and auxiliaries of battery operated fork lift truck.

l) The battery shall be installed within a heavy sheet metal enclosure mounted on top of the fork lift and wired suitably to the drive motor and other auxiliaries.

m) Battery shall be designed to withstand electrical and mechanical shocks.

n) The battery shall have capacity to meet the duty specified.

o) A low voltage protection shall be incorporated in the battery circuit to prevent excessive discharge of the battery. The sheet steel enclosure shall be provided with adequate ventilation and a cover for easy replacement. The enclosure shall be painted with acid resistant coat of paint. The cover shall be provided with lifting handles and arrangement for locking.

p) The battery shall be supported on porcelain insulators fixed on to the containers. The battery terminal posts shall be provided with connector bolts and nuts effectively coated to prevent corrosion. Lead coated copper connectors shall be used to connect up the cells of the battery set. The electrolyte used shall be of battery grade sulphuric acid conforming to IS:266.

18.02  Questionnaire

<table>
<thead>
<tr>
<th>SL NO</th>
<th>PARTICULARS</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Equipment No</td>
<td></td>
</tr>
<tr>
<td>ii)</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>iii)</td>
<td>Capacity, kg</td>
<td></td>
</tr>
<tr>
<td>iv)</td>
<td>Load centre, mm</td>
<td></td>
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<tr>
<td>v)</td>
<td>Numbers off</td>
<td></td>
</tr>
<tr>
<td>vi)</td>
<td>Type of tyre</td>
<td></td>
</tr>
<tr>
<td>vii)</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>viii)</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>ix)</td>
<td>Gradability</td>
<td></td>
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<tr>
<td>x)</td>
<td>Travel speed on level surface</td>
<td></td>
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<tr>
<td></td>
<td>Laden/Unladen, km/hr</td>
<td></td>
</tr>
<tr>
<td>xi)</td>
<td>Lifting &amp; lowering at rated capacity laden/unladen, m/s</td>
<td></td>
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<tr>
<td>xii)</td>
<td>Lowering speed at rated capacity laden/unladen, m/s</td>
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<td>xiii)</td>
<td>Height of lift, mm</td>
<td></td>
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<td>xiv)</td>
<td>Overall height</td>
<td></td>
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<tr>
<td></td>
<td>mast lowered, mm</td>
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<td></td>
<td>mast raised, mm</td>
<td></td>
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<tr>
<td>xv)</td>
<td>Free lift, mm</td>
<td></td>
</tr>
<tr>
<td>SL NO</td>
<td>PARTICULARS</td>
<td>DETAILS</td>
</tr>
<tr>
<td>-------</td>
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<td>---------</td>
</tr>
</tbody>
</table>
| xvi)  | Fork        | Spreading of forks, mm  
|       |             | Overall width x length, mm |
| xvii) | Overall dimensions | Length off fork, mm  
|       |             | Width, mm  
|       |             | Height with guard, mm |
| xviii)| Outer turning radius, mm |
| xix)  | Aisle width (90 deg turn) |
| xx)   | Total weight unladen kg:  
|       |             | with battery |
| xxii) | Motor details | Traction motor :KW x Rating  
|       |             | Pump motor     :KW x Rating |
| xxiii)| Speed control |
| xxiv) | Tilting angle of mast | Forward/ Backward, degree |
| xxv)  | Working hours |
| xxvi) | Ambient temp. |
| xxvii)| Working environment |
| xxviii)| Attachment |
| xxviii)| Battery charger unit suitable for power supply |
| xxix) | Traction Battery | Voltage, V  
|       |             | Capacity x Rating  
|       |             | Weight, Kg |
| xxx)  | Axle load Front/Rear, Kg in laden Condition |
| xxxi) | Any other special feature |
19  VULCANIZING MACHINE – MOBILE BELT CHANGING UNIT

19-A  BELT VULCANIZING MACHINE

Belt vulcanizing machines for belt splice of various widths (as indicated in data sheets) shall be supplied. The machine shall be easy to handle type. Heating element for Hot Belt Vulcanizing Machines shall be preferably of flexible type. The equipment shall be suitable for vulcanizing of entire splice width in single setting. It shall be capable of applying uniform pressure over splice by pneumatic or hydraulic means.

19-B  MOBILE BELT CHANGING UNIT

19-B.01  Scope of work

Mobile, truck-mounted belt-changing devices for quick replacement of conveyor belts of various widths shall be provided. The equipment shall safely unwind belts as well as wind and replace worn out belts. The equipment shall be provided with belt change reel stands, power belt reelers including pipe shaft, half split bush bearing at ends, geared motor etc.

It shall consist of a truck or tractor unit and a trailer platform mounted with equipment required for belt changing.

19-B.02  Design Data

1. The truck / tractor shall be complete with following facilities:
   
   a) Cabin with seating facility for minimum 5 persons and a driver. The cabin shall have latest driving facility for driver.
   
   b) It shall be equipped to tow 30t-loaded trailer on road with upward gradient of 1 in 12 (minimum).
   
   c) It shall be of reputed make and model complete with all the necessary attachment to drive in the night and dust/ hazardous condition without any external support.
   
   d) Tools & tackles for maintenance of truck / tractor / platform trailer including hydraulic jack for lifting the truck / tractor / trailer for wheel changing.

2. The belt-changing device mounted on the platform trailer shall have following features:
   
   a) The trailer platform has min 12 numbers rubber tyred wheels (8 numbers on 2 rear axles and 4 numbers on 2 front axles). It shall have suitable turning devices for achieving low turning radius to enable it to be maneuvered by the truck/tractor on narrow plant roads and its easy placement at proper locations for belt changing operation. The trailer platform shall have min. 4 nos. out-riggers for application during belt changing operation.
   
   b) It shall consists of a manual winch (with 60m of wire rope for threading the old belt to the empty reel), spring loaded cable reeling drum (with 60 m of power cable), individual drive assemblies for rotating an “Empty reel” (for pulling the old belt out of the conveyor system and winding the same on the reel) and a “Loaded belt reel” (to un-wind new
belt out of the reel), equipment for maintaining constant circumferential speed of both belt reels and complete with motor starter panel, electrical controls and instrumentation. The system shall also be provided with 4 numbers mandrels (to put inside the wooden belt reels for rotation, 2 numbers working, 2 numbers spare) and 2 Nos. wooden reels (for belts), along with any other accessories that may be required to for belt changing operation.

c) The drives for “Empty reel” and “Loaded belt reel” shall have electric motors, reducers, resilient couplings and brakes. (Alternatively, low speed-high torque hydraulic motors with power pack etc mounted on the platform trailer, may also be considered). Adequate pulling force as per the requirement or 20t ( whichever is more) shall be considered.

Both the drive systems shall act in tandem to maintain constant circumferential speed of both drums at 15 m /min. Provision of creep speed shall also be kept for intended operation. The whole system shall be electrically/ electronically controlled to maintain constant speed of incoming and outgoing belt.

d) Spring loaded resilient coupling/ twin diaphragm resilient coupling shall be provided on output side of gear box, between fluid coupling & gear box and between motor & fluid coupling for drives with motor rating above 30kW.

e) Two Nos. of belt gripping devices (one for old and one for new belt) including fasteners & necessary rope fixing arrangement shall be provided. It shall be made of Aluminium alloy and shall be mounted on self-locking chuck to ensure safety of operator. One spare gripping device meant for spare belt shall also be provided.

f) The trailer platform shall have two sets of “A” frames for mounting the “Empty reel as well as “Loaded belt reel”. The two reels shall be mounted individually on mandrels (minimum 100 mm square bars/ hollow sections) of adequate length, for supporting them over pivot block of respective “A” frame. The belt reels shall be “locked” longitudinally on the mandrels. One end of the square bar is coupled with drive mechanism through love-joy coupling. Mandrel shall be placed on a chuck so that after placement it can be locked with chuck. Both sides of mandrels shall be placed on bearing block to offer least resistance during operation.

g) Adequate space on the truck deck shall to be provided for transporting vulcanizing unit, too kit box, belt stretching device, mounting of MCC and for standing and movement of operating personnel. Dimension of vulcaniser shall be intimated to the successful Bidder.

h) The trailer shall be designed and selected such that it can remain stable during operation of the winch considering the rope pull from any possible direction. Out riggers and ballast (if necessary) shall be provided in the trailer. The maximum speed of the vehicle shall be 25 kmph.

i) All gears of the gearbox shall be of hardened and tempered alloy or carbon steel with machine cut teeth. The bearing-supporting block for pivoting the mandrel shall be horizontally split type with easy mounting facility. All gears shall be splash lubricated and bearings shall be grease/splash lubricated. Gearbox shall be totally enclosed.
j) Circumferential speed of the belt at the stabilized condition of changing shall be minimum 15m /minute. Suitable thyristor control / resistance control shall be designed to maintain constant circumferential speed of incoming & outgoing belts from the individual “Reels”. Suitable speed sensors required for maintaining constant circumferential speed shall be provided. The control panel for operation of the belt-changing device shall be mounted on common based frame. In case of hydraulic motor, the panel shall be mounted on power pack.

k) 60 m length of cable shall be supplied with suitable connector for connecting to the source of power provided in the gallery/ Jn. Houses. Suitable spring loaded cable reeling drum shall be provided on the trailer to wind the cable.

19-B.03 DOCUMENTATION

1. Drawings and document to be submitted by Tenderer

   a) Technical Parameters, constructional features and details of Equipment along with General Arrangement drawings.

   b) Motor rating

   c) Operating weight

   d) Filled up Questionnaire

2. List of drawings /data to be submitted by the successful tender

   a) General arrangement drawing with bill of material of equipment showing overall dimension & details.

   b) Supplier's name for components & catalogues for these items shall be furnished.

   c) List of commissioning spares proposed by the Tenderer.

   d) List of recommended spares for two years maintenance of plant and equipment along with itemised price.

   e) List of tools and tackles to be supplied with the plant and equipment.

19-B.04 Questionnaire

Type & Name of Supplier

Technical Parameters:
CIVIL

(CHAPER-07)
GENERAL TECHNICAL SPECIFICATION
FOR
CIVIL ENGINEERING WORKS
(GS – 07)
CIVIL

(CHAPTER-07)
# SPECIFICATION FOR CIVIL ENGINEERING WORKS

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1.0  GENERAL

1.1  Scope

This part deals with the requirements of materials for use in construction work with regard to quality, testing, approval and storage, before they are used on work. This part is supplementary to Part-II: Workmanship and Other requirements of the Technical Specifications for civil works.

1.2  Standard

A high standard of quality is required for all materials used in construction work. They shall be the best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and assurance of timely supply.

1.3  Approval and Tests

1.3.1  All materials to be used in construction shall be subject to approval of the Engineer. The Contractor shall apply sufficiently in advance with samples of the materials including the supporting test results from the approved laboratory and other documentary evidence from the manufacturer wherever applicable and indicating the types of materials and their respective sources. The delivery of materials at site shall commence only after the approval of the quality, grading and sources of the materials by the Engineer.

1.3.2  The quality of all materials once approved shall be maintained throughout the period of construction and periodical tests shall be carried out to ensure that it is maintained. Such routine tests shall be listed under the different materials and/or as may be ordered by the Engineer from time to time.

1.3.3  Where a particular “Brand” or “Make” of material is specified in the Schedule of Items or Technical Specifications, such “Brand” or “Make” of material alone shall be used on the work. Should it become necessary for any reason (such as non-availability/ceased to be produced), to use any material other than the specified “Brand” or “Make”, the Contractor shall submit sample of the same to the Engineer for approval together with test certificates and other documents necessary for examining and giving approval thereof. Should such change or substitution of materials, subsequently approved, results in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately reduced. Similarly, in case the substitution results in use of material of price higher than that specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately increased.

1.4  Codes

1.4.1  The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

1.4.2  In case of any conflict in meaning between these specifications and those of BIS or IRC, or British /International Standard; the provisions of these specifications shall prevail.

1.5  Rejection of Materials
1.5.1 Any material brought to site which, in the opinion of the Engineer is damaged, contaminated, deteriorated or does not comply with the requirement of this specification shall be rejected.

1.5.2 If the routine tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification or of I.S. Codes as applicable, then that material shall be rejected.

1.5.3 The Contractor at his own cost shall remove from site any and all such rejected material within the time specified by the Engineer.

2.0 MATERIALS FOR CONCRETE

2.1 Aggregates

2.1.1 Aggregates shall comply with the requirements of IS: 383-1970 “Coarse and Fine Aggregates for Concrete”. They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalies of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

2.1.2 Testing

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386-1963 "Methods of Test for Aggregates for concrete".

2.1.3 Grading

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete made therefrom to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

2.1.3.1 Size and grading of fine aggregates

The grading shall conform to IS: 383-1970 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

2.1.3.2 Size and grading of coarse aggregates

The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall depend upon the description of the particular item in the Schedule of Items and/or according to relevant clauses of IS: 456-1978. The aggregates shall be well...
graded and the grading shall conform to relevant requirements of IS: 383-1970 depending upon the maximum nominal size as specified or as required.

2.1.3.3 Fine aggregate for mortar and grout

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and IV as defined in IS: 383-1970.

2.1.4 Storage & stacking

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate. In case of stockpiling, care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

2.2 Coarse Aggregates

2.2.1 Types

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

2.2.2 Stone chips

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383-1970. If found necessary the stone chips shall be screened and washed before use.

2.2.3 Gravel

It can be either river bed shingle or pit gravel. It shall be sound, hard, clean, irregular in shape and suitably graded in size with or without some broken fragments. It shall be free from flat particles, powdered clay, silt, loam and other impurities. Before using, the gravel shall be screened and washed to the satisfaction of the Engineer. However, the foreign/deleterious materials shall not exceed 5% by weight.

2.2.4 Broken bricks / Brick aggregates

DELETED

2.3 Fine Aggregates

2.3.1 Unless specified otherwise it shall either be natural river sand or pit sand.

2.3.2 Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other impurities which is likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screened or washed before use to the satisfaction of Engineer.
2.3.3 Crusher dust

Crusher stone dust (that is retained on 300 micron sieve) only to be used under floors or at locations where ever sand filling is generally used. In this project sand filling is not to be used. In cases wherever sand filling is specified/indicated, the same is to be replaced with crusher dust.

2.4 Lime

Lime for mortars and concrete shall conform to IS: 712-1984. The total of CaO and MgO content in quick lime shall not be less than 85% (MgO shall not exceed 5%). Quicklime, after slaking, shall leave a residue of not more than 5% by weight on IS sieve 85.

2.5 Surkhi

DELETED

2.6 Cement

Ordinary Portland cement / Portland slag cement complying with the requirements of IS:269-1989 and I.S. 455-1989 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:

<table>
<thead>
<tr>
<th>Cement Type</th>
<th>IS Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Pozzolana Cement</td>
<td>1489-1991</td>
</tr>
<tr>
<td>Rapid Hardening Portland Cement</td>
<td>8041-1990</td>
</tr>
<tr>
<td>43 Grade Ordinary Portland Cement</td>
<td>8112-1989</td>
</tr>
<tr>
<td>53 Grade Ordinary Portland Cement</td>
<td>12269-1987</td>
</tr>
<tr>
<td>Hydrophobic Portland Cement</td>
<td>8043-1991</td>
</tr>
<tr>
<td>High alumina cement for structural work</td>
<td>6452-1989</td>
</tr>
<tr>
<td>White portland cement</td>
<td>8043-1989</td>
</tr>
<tr>
<td>Sulphate Resisting Portland Cement</td>
<td>12330-1988</td>
</tr>
</tbody>
</table>

2.6.1 Testing of samples

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535-1986. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) 1988 to 1991 & IS: 4032-1985.

2.6.2 Contractor's responsibility

From the time a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition and at his expense and risk. Any cement which deteriorates while in the Contractor's charge and is rejected...
as unsuitable by the Engineer, shall be removed from the site to outside the limits of work at the cost of contractor within two days of ordering such removal by the Engineer.

2.6.3 Stock of cement

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

2.6.4 Storage of cement

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

2.7 Water

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '8'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-1978. Water shall be obtained from an approved source. Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.

2.8 Admixture for Concrete

2.8.1 Approval

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

2.8.2 Types

2.8.2.1 Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645-1975. The application and doses shall be as per manufacturer's specification.

2.9 Interval of Routine Test

2.9.1 The routine tests of materials, delivered at site, shall be at the following intervals:

- Aggregates: Fortnightly or for every 200 m³ for each aggregate whichever is earlier and in other respects generally as per IS : 2386 (Part 1 to 8)-1963.
- Cement: Fortnightly or for each consignment, within 4 days of delivery and in other respects generally as per IS : 4031-1988.
3.0 STEEL

3.1 For Reinforcement

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing:

i) Plain mild steel bars conforming to Grade-I of IS : 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".

ii) "High strength deformed steel bars conforming to IS : 1786-1985 for Concrete Reinforcement".

iii) Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Further all diameters supplied in coils need to be straightened by mechanical means using straightening machines as required. Unit weight of reinforcement bars conforming to I.S. 1786-1985 is as given below.

<table>
<thead>
<tr>
<th>Nominal Size (Dia) (mm)</th>
<th>Mass Per Metre Run (Kg)</th>
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<tr>
<td>6</td>
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<tr>
<td>8</td>
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</tbody>
</table>

3.2 Binding wire

Binding wire for reinforcement shall be annealed steel wire 20 BWG conforming to IS : 280-1978 "Specification for Mild Steel Wire".

3.3 Light structural work and inserts

Steel for light structural work and for preparation of inserts and embedments shall conform to IS: 2062-1992 "Steel for general structural purposes - Specification."
3.4 Steel Tubes

Steel tubes for use in light structural work and inserts shall be of light or medium class (as may be specified in drawings or the schedule of items) and of grade YST 25 conforming to IS : 1161 - 1979 "Specification for Steel Tubes for Structural Purposes".

3.5 Foundation Bolts

3.5.1 Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS : 5624-1970 "Specification for Foundation Bolts". Material for bolts, shall, be of steel conforming to IS : 2062-1992 or as per details provided in drawings based on Technical requirement.

3.5.2 Nuts and locknuts shall conform to IS : 1363 (Part 1 to 3) -1992 "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (Diameter 6-39 mm) and Black Hexagon Screws "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".

3.5.3 Plain washers shall conform to IS : 2016 -1967 "Specification for Plain Washers and spring washers shall conform to IS : 3063 -1972 "Spring Washers for Bolts, Nuts & Screws".

3.6 Steel Tubes for Non-structural use

3.6.1 Steel tubes for non-structural use shall conform to IS : 1239 (Part-I) -1990 "Specification for Mild Steel Tubes, Tubular and Other Wrought Steel fittings, Part-I : Mild Steel Tubes".

3.6.2 Fittings for steel tubes used for non-structural purposes shall conform to IS : 1239 (Part-II) -1992 "Specification for Mild Steel Tubular and Other Wrought Steel Pipe Fittings".

3.7 Threaded Fasteners

Bolts and nuts for fastening shall conform to IS:1367 (Part 1)-1980 "Technical Supply Conditions for Threaded Fasteners".

3.8 Testing


3.9 Cast Steel

3.9.1 Quality

Cast steel shall conform to IS : 1030-1989 "Carbon Steel Casting for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade2.

3.10 Conduits

3.10.1 Steel for electrical wiring


All conduit pipes shall be finished with galvanised or stove-enamelled surface. All accessories shall be of threaded type and pipes shall be jointed by means of screwed couplers only. Bend in conduits shall be made to the dimension shown in drawing, but a minimum of 12 times the diameter. Where shown in drawing they shall be treated with anticorrosive preservative as specified.
3.10.2 Non-metallic conduit for electrical wiring


Bends shall be achieved by bending the pipes by inserting suitable solid or inspection type normal bends, elbows or similar fittings.

4.0 ASBESTOS CEMENT PRODUCTS

4.1 General

Asbestos cement products shall be free from visible defects, uniform in colour, of required density, length, thickness and diameter within the allowable tolerance. They shall be obtained from an approved source of manufacture and stored safely. Methods of test shall be according to IS:5913-1989 "Method of Test for Asbestos Cement Products."

4.2 Building Boards

These shall be of Class A, B and C with board thickness being 6.5mm, 5mm and 4mm respectively. The length shall be 2400, 1800 and 1200mm and width in all cases 1200 mm. Building boards shall conform to IS : 2098 - 1964 "Asbestos Cement Building Boards". They shall, when tested in two perpendicular directions, take a load of not less than 15 kgf for Class-A and 10 Kgf for Class-B and Class-C boards. The boards shall show water absorption of not more than 40% of their dry weight.

4.3 Flat Sheets

Flat sheets shall conform to IS : 2096-1992 "Asbestos Cement Flat Sheets". They shall have a bending stress of not less than 225 kgf/cm² & a density of 1.6 kg/dm³ for compressed sheets & a bending stress of not less than 160 kgf/cm² and a density of 1.2 Kg/ dm³ for uncompressed sheets. Nominal thickness shall be 5,6,8,10 and 15 mm, length 2400, 1800 and 1200mm and width 1200mm. Water absorption shall not exceed 28% of dry wt.

4.4 Pipes and fittings


Pressure pipes shall satisfy Hydraulic test and transverse crushing test as per IS : 5913-1989.

4.5 Corrugated and Semi-Corrugated Sheets

These shall conform to IS : 459 -1992 "Unreinforced Corrugated and Semi-Corrugated Asbestos Cement Sheets". Unless otherwise stated the sheets shall be corrugated and not less than 6mm thick. The sheets shall have a load bearing capacity of not less than 5 N/mm width of specimen and shall not absorb more water than 28% of its dry weight. Overall width of corrugated sheets is 1050mm and of semi-corrugated sheet is 1100mm.

4.6 Asbestos Cement Roof fittings
These shall conform to IS : 1626 (Part 3)-1981. Shapes and dimensions shall be as given in the above mentioned code. All finished products shall be free from visual defects that impair appearance or serviceability. Surface of fittings shall be of uniform texture and shall have neatly trimmed edges. Mean water absorption shall not be more than 28% of dry mass of the material.

5.0 BRICK AND STONES

5.1 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 5 N/sq.mm., or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Underburnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS : 3495 (Parts-1 to 4) -1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in table 1 of IS : 1077-1992.

5.2 Handling

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

5.3 Samples and Inspection

Representative samples shall be submitted by the contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and shall be to the approval of the Engineer who may reject such consignment as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer without additional charges.

5.4 Brick Bats

DELETED

5.5 Laterite Stone Blocks

These shall conform to IS : 3620 -1979 "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum compressive strength of 30 kg/cm² and to be tested as per IS : 1121-1974. The blocks shall be minimum 15 cm thick but not exceeding 30 cm. They shall be dressed to the desired sizes and shapes with an axe. Laterite stones shall be well seasoned by exposure to air before dressing and using on work.
5.6 Stone (granite, trap, sandstone, quartzite etc.)

5.6.1 Stone used shall be strong, durable, dense, compact, close grained, homogeneous, fire resistant and shall be obtained from sources approved by Engineer. Stones shall additionally be hard, sound, free from cracks, decay and other flaws or weathering and shall be easily workable. Stones with round surfaces shall not be made use of.

5.6.2 Stones shall have a crushing strength of not less than 200 kg/cm². Stones with lesser crushing strength may be used in works with prior approval of the Engineer. Stones shall be non-porous and when tested in accordance with IS : 1124 -1974 "Method of Test for Determination of Water Absorption Etc.:" shall show water absorption of less than 5% of its dry weight when soaked in water for 24 hours. Tests for durability and wheathering shall be done in accordance with IS : 1126-1974 and IS : 1125-1974 respectively. The working of stones to required sizes and their dressing shall be as per IS : 1127-1970 "Recommendations for dimensions and workmanship of natural building stones for masonry work" and IS : 1129 -1972 "Dressing of Natural Building Stones". Stones especially limestone and sand stones shall be well seasoned by exposure to air before use in construction works.

5.6.3 Size

Normally stones shall be of size that could be lifted and placed by hand, between 20 to 30 kg per piece. The length of stones shall not exceed 3 times the height and the breadth on base shall not be greater than 3/4 of the thickness of wall or less than 15cm. The height of stone may be upto 30cm.

5.6.4 Dressing

5.6.4.1 Random rubble

Stones shall be hammer dressed on the face, the sides, and the beds to enable it to come into close proximity with the neighbouring stone. The bushings in the face shall not project more than 4cm on all exposed faces and 2cm on a face to be plastered, nor shall it have depressions more than 1cm from the average wall surface.

5.6.4.2 Coursed rubble - First sort

Face stones shall be hammer dressed on all beds, and joints, so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for atleast 5cm back from the face, and side joints for atleast 4cm such that no portion of the dressed surface is more than 6mm from a straight edge placed on it. The bushing on the face shall not project more than 4cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 2.5cm along the four edges of the face of the stone, when stone work is exposed.

5.6.4.3 Coursed rubble - Second sort

Dressing shall be as specified in 5.6.4.2 except that no portion of dressed surface shall exceed 10mm from a straight edge placed on it as against 6mm for first sort.

5.6.4.4 Stone for veneering

Stone lining upto 8cm shall be treated as veneering work. The stone shall be cut into slabs or required thickness along the planes parallel to the natural bed. Every stone shall be cut to the required size and shape so as to be free from any waviness and to give truly vertical and horizontal joints. Adjoining faces shall be fine chisel dressed to a depth of a 6mm, so that when checked with a 60cm straight edge, no point varies from it by more than 1mm.
All edges shall be chisel dressed to be true, square and free from chippings. Top and bottom faces shall be dressed to within 3mm tolerance and vertical faces to within 6mm tolerance, when checked with a 60mm straight edge. Dressing at the back shall not be done.

5.7 Hollow and Solid Concrete Blocks

5.7.1 Cement concrete blocks used in the construction of concrete masonry load bearing as well as non-load bearing walls shall conform to the requirements of IS : 2185 (Part 1)-1979. Physical properties such as density, compressive strength, water absorption etc., shall be determined in accordance with the procedure laid down in IS : 2185 (Part 1) -1979 and shall conform to the requirement laid therein. When inspected visually all blocks shall be sound, free from cracks, broken edges, honeycombing and other defects which would interfere with the proper placing of blocks or impair strength or permanence of construction.

5.7.2 Dimensions and tolerance

The blocks shall be made in sizes and shapes to suit the particular job and shall include stretcher, corner, double corner or pier, jamb, header, bullnose and floor units.

5.7.2.1 The nominal dimensions of concrete block shall be as follows:

Length : 400, 500 or 600mm  
Height : 200 or 100mm  
Width : 50, 75, 100, 150, 200, 250 or 300mm

In addition, blocks shall be manufactured in half and other suitable lengths and shapes to suit Architectural requirements.

5.7.2.2 The maximum dimensional tolerances shall be plus or minus 5mm in length and plus or minus 3mm in height and width.

5.7.3 Hollow blocks (open and closed cavity)

5.7.3.1 The blocks having solid material about 50% to 75% of total volume of the block calculated from the overall dimensions shall be termed as hollow blocks. Grade-A blocks used as load bearing units shall have a minimum block density of 1500 kg/m3 and shall have minimum average compressive strength of 3.5, 4.5, 5.5 or 7.0 N/mm2 at 28 days as specified.

5.7.3.2 Grade-B Blocks used as load bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and shall have compressive strength of 2.0, 3.0, or 5.0 N/mm2 or as specified.

5.7.3.3 Grade-C blocks used as non load bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and compressive strength of 1.5 N/mm2 at 28 days.

5.7.4 Solid blocks

The blocks having solid material more than 75% of the total volume of the be block shall be termed as solid block. Solid blocks (Grade-D) used as load bearing units shall have a block density of not less than 1800 kg/m3 and compressive strength of 4.0 or 5.0 N/mm2 as specified.

5.7.5 Mix proportion
The concrete mix used for blocks shall not be richer than one part by volume of cement to six parts by volume of combined aggregates before mixing.

5.7.6 Surface texture and finish

Surface texture, that is, very fine closed texture or coarse open texture and finish, whether coloured or not shall be according to the drawing, description in the Schedule of Items or instructions of the Engineer.

5.7.7 Marking and certificate

The blocks shall be marked permanently indicating the Grade of the unit, identification of the manufacturer and the year of manufacture. Manufacturers test certificate shall be supplied with the delivery of each lot.

5.8 Cement, Lime and Water

Cement, lime and water shall conform to the specification under the Section Concrete of this part.

5.9 Sand for Masonry Mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS : 2116 - 1980 "Sand for Masonry Mortars". The sand shall be hard, durable, clean and free from adherent coatings and shall not contain amount of clay, silt and fine dust more than 5% by wt. Sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. The particle size grading of sand for use in mortars shall be within the limits as specified in Table I of above code.

6.0 SAND FOR PLASTERING

Sand for use in mortars for internal wall, ceiling and external plastering and rendering shall conform to IS:1542 -1992. It shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. Percentage of salt and dust shall not be more than 5% by weight. Grading of sand shall be within the limits specified in clause no. 5.1 of above code. Fineness modulus of naturally occuring sand shall not be less than 1.5.

7.0 MATERIALS FOR FLOORING & PAVING

7.1 Cement and Binders

7.1.1 Cement

Cement, fine aggregates, reinforcement and water used shall comply with the requirements of concrete as per clauses 2.1, 2.3, 2.6 and 2.7 of this part.

7.1.2 Water

Water for construction shall be clean, soft, free from loam, salt and organic materials. Hard water shall not be used.

7.2 Aggregates

7.2.1 Coarse Aggregate
7.2.1.1 Coarse aggregate shall conform to the requirement as per clauses 2.1 and 2.2 of this part.

7.2.1.2 For granolithic floor the screeded bed shall comprise of aggregates size 15mm and down graded and topping shall comprise of clean fine stone chippings, size 4mm and down. For concrete floor with hardener treatment the topping shall comprise of stone chippings, size 6mm and down and for in-situ terrazzo flooring, chippings shall be within sizes 12mm to 6mm graded. The marble chips for topping of terrazzo floor shall be of 3-6mm size and shall conform to Grade-I of IS : 2114-1984 "CP for laying in-situ terrazzo floor finish".

7.2.2 Common burnt clay bricks

Common burnt clay bricks shall conform to IS : 1077-1992 and comply with requirements under the section "Brick and Stones" of this part.

7.2.3 Rubble

Rubble of approved quality shall be used and shall be clean and free from dirt. The loose and weathered sections shall be removed before use. Rubble used as hard core shall have a least lateral dimension (thickness) between 100mm and 225mm, depending on the thickness of hardcore.

7.3 Tiles

7.3.1 Terrazzo Tiles

Terrazzo tiles shall be machine made under a minimum pressure of 140 kg/cm². It shall have a minimum total thickness of 20mm including a minimum of 6mm thick topping. It shall be of size, texture, colour, shade and pattern as specified in schedule of item and as approved by the Engineer.

7.3.2 White Glazed Tile

White glazed tiles shall be of approved manufacture and quality and shall conform to IS:777 - 1988 "Glazed Earthenware Tiles. They shall be true in shape, free from hair cracks, crazing spot, chipped edges and corners and surface shall be perfectly flat without warps and of uniform colour. The top surface shall be glazed either gloss or matt as specified. The tiles, normally shall be 149mm x 149mm or 99mm x 99mm size and shall not be less than 5mm thick or as specified. The tolerance on average facial dimension value shall be plus or minus 0.8 and on thickness plus or minus 0.5mm. The specials such as coves, internal and external angles, beads, cornices and their corner pieces shall be of specified sizes and of thickness not less than the thickness of tiles.

7.3.3 Coloured tiles

Only glaze shall be coloured as specified. The size and specification of tiles shall be same as for the white glazed tiles.

7.3.4 Marble tiles

It shall conform to IS : 1130 -1960 "Marble (Blocks, Slabs and Tiles)". Marble for paving and facing work shall be of selected quality, hard, sound, dense and homogeneous in texture (with crystalline texture) and free from cracks, decay, weathering and flaws and shall be of kind and quality, size and thickness as specified in schedule of items. The samples of tiles shall be got approved by the Engineer before use. The tiles shall be cut to the requisite dimensions.
7.4 Pigments

Pigments incorporated in mortar or used for grouting shall be subject to approval of Engineer and as per table I of IS : 2114-1984.

7.5 Red Oxide of Iron

Red oxide of iron where used for "Red Artificial Stone Flooring" shall be of quality approved by the Engineer, and shall be of uniform tint.

7.6 Hardening Agents

Hardening agents such as ironite used for "Cement Concrete Flooring with Hardener Treatment", shall be of quality approved by the Engineer for every work.

7.7 Dividing Strips

Dividing strips shall be of aluminium, glass, brass, copper, plastic or similar materials as specified in the schedule of item and of quality approved by the Engineer. Strips shall be 1.5 mm thick unless otherwise specified penetrating to the full depth of the flooring. Aluminium strips when used shall have a protective coating of bitumen.

7.8 Marble Chips

It shall be in sizes varying from 1mm to 25mm and in different colours as per requirement. Marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from cracks, stains, decay and weathering and shall be obtained from approved source.

7.9 Marble Powder

It shall be clean, free from dust and other foreign materials and of approved quality, obtained from approved source. It shall pass through sieve 300 conforming to IS: 460-(Part-1)-1985.

8.0 TIMBER

8.1 General

All timber used for carpentry and joinery works shall be new. It shall be well seasoned by a suitable process conforming to IS : 1141-1973 before being planed to the required sizes. It shall be sound, straight, free from sap, radial cracks, decay, fungal growth, boxed heart, pitch pockets, borer holes, splits, loose knots, flaws or any other defects and shall show a clean surface when cut. Timber shall conform to the requirements of IS : 1003 (Part 1&2)-1983 to 1991. The finished components shall be given suitable preservative treatment wherever necessary.

8.2 Teak wood/Sal / Bija Sal / Deodar / Kail and other varieties of timber

8.2.1 Teak wood

The timber shall be of good quality and well seasoned. It shall be of fairly uniform colour and shall be free from defects such as cracks, dead knots, shakes etc. No individual hard and sound knot shall be more than 15 sq. cm. in size and aggregate area of all such
knots shall not exceed 2 % of the area of the piece. Wood shall be generally free from sap wood but traces of the same shall be allowed. The timber shall be fairly grained having not less than 2 growth per cm width in cross section.

8.2.2 Sal / Bija Sal wood

Timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 6 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall not be less than 5 growth rings per 2 cm of the width.

8.2.3 Deodar wood

The timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 15 sq.cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall be at least 3 growth rings per cm width in cross section.

8.2.4 Kail wood

The timber shall be generally as specified in clause 8.2.3 for Deodar wood. However, there shall not be less than 2 growth rings per cm width in cross section.

8.2.5 Other varieties of timber

The timber as named in the item of work shall be used. It shall be well seasoned and generally free from defects such as dead knots, cracks, shakes, sap wood etc. However, traces of sap wood shall be allowed and sound and hard knots up to 2 % of the area of the piece shall be allowed.

8.3 Storage and Inspection

Timber shall be carefully stored and subject to inspection on site, piece by piece. The Engineer may reject such pieces as are considered by him not of the quality or meeting the requirements specified herein.

8.4 Moisture Content

Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS : 287-1973.

8.5 Tolerances for Timber

For timber allowance as specified in the IS : 1003 (Part 1&2) 1983 to 1991 shall be applicable.

8.6 Flush Door Shutters, Shelves

Flush door shutters, shall be wooden, solid core or cellular and hollow core type, as may be shown in drawing or described in the Schedule of Items or directed by Engineer. They shall be obtained from an approved source of manufacture, covered on face with commercial ply, wood veneer or other finish as may be necessary. Solid core shutters shall conform to IS : 2202 (Part 1&2)-1983 to 1991 and cellular or hollow core shutters to IS : 2191 (Part 1&2)-1983. The resin used shall be phenol formaldehyde. A full size sample door shall be offered for inspection and approval.
8.7 Wood Particles Boards

Particle boards for general purposes shall be of medium density conforming to IS:3087-1985. These are of four types, Flat pressed single layer board (FPSI), Flat pressed three layer board (FPTH), Extrusion pressed solid board (XPSSO) and Extrusion pressed tubular core (XPTU). Adhesive shall be BWR, WWR or un-extended CWR type. High density wood particle board shall conform to IS:3478-1966 and are in flat sheets or moulded forms. These shall be of type 1 (BWR type of resin) or Type 2 (WWR or CWR type of resin). Both types of boards shall be of Grade A (resin content 20 to 50 percent) and Grade : (resin content 8-12 percent).

8.8 Veneered Particle Board

These shall conform to IS : 3097-1980 and shall be of two grades. Exterior (grade-I with BWP or BWR type adhesive) & interior (grade-II with WWR or CWR type adhesive). Each grade of boards shall be of 4 types, solid core general purpose, solid core decorative, Tubular core general purpose and Tubular core decorative and accordingly designated.

8.9 Plywood for General Purpose

Plywood for general purpose shall conform to IS:303-1989. Depending on type of adhesive used for bonding veneers, it is of 4 grades, BWP (boiling water proof), B.W.R (boiling water resistant), WWR (warm water resistant) and CWR (Cold Water resistant). Any species of timber may be used for plywood manufacture. However list of species, for the manufacture of plywood is given in Annexure 'B' of the IS : 303-1989 for guidance.

Plywood is classified in 10 different types as per appearance of the surface. These are type AA,AB,AC,AD,BB, BC,BD,CC,CD and DD as detailed in IS : 303-1984. It is available from 3 ply to 11 ply with thickness from 3mm to 25mm.

8.10 Veneered Decorative Plywood

This quality of plywood shall conform to IS : 1328-1982. These plywood shall be of two types Type 1 and Type 2 as per details given in IS : 1328-1982. Species of timber for decorative face commonly used are given in Table 1 of IS : 1328-1982 but the purchaser shall specify the particular veneer to be used. Timber for cores and backs shall be either class I or II as specified in IS : 303-1989. Adhesive used shall be BWR or WWR synthetic resin.

9.0 FITTINGS FOR DOORS, WINDOWS, ETC.

9.1 General

Fittings shall be of iron, brass, aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enameled or copper oxidised or painted as specified. Brass fittings shall be finished bright, oxidised or chromium plated and aluminium fittings shall be finished bright or anodised as specified. Fittings shall be got approved by the Engineer before fixing. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodised cadmium/chromium plated M.S. screws of approved quality shall be used for fixing aluminium fittings.

9.2 Hinges
9.2.1 Butt hinges

These shall be mild steel but hinge (medium), brass butt hinges, extruded aluminium alloy butt hinges or as specified. Type (light/medium/heavy weight) and size shall be as specified in the drawing or schedule of items. Brass / Aluminium and M.S butt hinges shall conform to Indian Standard Specification for butt hinges IS : 205-1992 and IS : 1341-1992 respectively. Hinges shall be finished bright or satin polished or anodised.

9.3 Sliding Door Bolts

Mild steel sliding door bolts shall conform to IS : 281-1991 and are of 2 types, plate type and clip or bolt type. Plate type bolts shall have plates and straps stove enameled black with hasp and bolt finished bright or copper oxidized or nickel / chromium plated. Clip or bolt type are copper oxidized or plated. All screw holes in the M.S bolts shall be countersunk. Diameter of bolt for plate type is 12mm and for clip type is 16mm.

Non ferrous metal sliding doors are of brass or aluminium alloy and shall conform to IS:2681-1979. Brass sliding bolts are of 150 to 450mm size with bolt dia being 16mm for 150 to 300mm and 18mm for 375 and 450 size. Aluminium alloy sliding bolts are of size 200 to 450mm with 16mm bolt dia. Brass quality is finished satin, polished or plated and aluminium alloy bolts are anodised.

For both ferrous and non-ferrous metal bolts the size of the sliding bolt is determined by the length of the bolt.

9.4 Door Rim Latch

This shall be of mild steel, brass, aluminium alloy or as specified and of sizes 75, 100, 125 and 150mm denoted by overall length of the body measured from outside face of the fore end to the rear end. These are of type 1 and type 2 and shall conform to IS: 1019-1974.

9.5 Tower Bolts

Tower bolts may be of one of the following types and shall conform to IS : 204 (Part 1 and 2)-1991 and 1992.

i) Barrel tower bolts

These shall be of bright finished/stove enameled/ black painted mild steel tower bolts, brass barrel tower bolts with cast brass barrel and rolled or drawn brass bolt/brass barrel tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt/brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt. Aluminium barrel tower bolts with barrel and bolt of extruded section of aluminium alloy-bolts and barrel anodised.

ii) Semi-barrel tower bolts

These shall be mild steel semi barrel tower bolts full cover/open type with mild steel sheet pressed barrel and cast iron/mild steel bolt. Bolt bright finished other parts stove enameled black.

iii) Rivetted or spot welded tower bolts
These shall be mild steel tower bolts rivetted type with black flat and mild steel/cast iron bolt and open staple.

iv) Skeleton tower bolts

These shall be of bright finished / stove enameled / black painted mild steel or brass bright finished skeleton tower bolts with cast brass/extruded sections plate and staples and rolled or drawn brass bolt or Aluminium skeleton tower bolts with plates staples and bolt or extruded sections of Aluminium alloy plate and staple anodised.

9.6 Door Handles

Door handles shall conform to IS : 208-1987 and shall be of 4 types. Type 1 is cast Iron / Brass / Aluminium or zinc alloy die casting and available in 75,100,125 150mm sizes. Type 2 is mild steel pressed oval in 75, 100,115 and 135mm sizes. Type 3 is mild steel present half oval in 75,90 and 100mm sizes. Type 4 is fabricated (brass / aluminium alloy) in 75,100 and 125mm sizes. The size of the handle shall be determined by inside (grip) size overall size and internal depth of the handles shall be as detailed in IS : 208-1987.

Finish for type 1 shall be satin/nickel plating, copper oxidising and bronze finish for cast-brass and zinc die cast handles and stove enamelled black or copper oxidized for cast iron handles. Aluminium handles shall be anodized. Type 2 and 3 handles shall be stove enamelled black. For type 4 it shall be satin finish, nickel plating, copper oxidized and bronze finish for brass handles and anodizing for aluminium handles.

9.7 Mortice Lock and Rebated Mortice lock

Mortice lock with latch and pair of lever handles shall have body of steel, Aluminium alloy or brass and shall be right or left handed as shown in the drawing or as directed by the Engineer. It shall be of the best Indian make of approved quality and shall conform to IS: 2209 / 6607-1976/1972. The shape and pattern shall be approved by the Engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face. Lever handles with springs shall be mounted on plates and shall weigh not less than 0.5 kg per pair. These shall be of brass, finished, bright chromium plated or oxidised. The locks shall be of 65, 75 and 100 mm sizes.

9.8 Floor Door Stopper

These are for the use of the door shutters of 30, 35,40 & 45mm thickness. It is made of aluminium alloy/ brass with springs of phosphor bronze or hard drawn steel wire and tongue of aluminium/brass/nylon/ plastic. The floor door stoppers shall conform to IS : 1823-1980 and shall be best Indian make of approved quality. Width of cover plate is 40mm but its overall length is 140mm for 30 and 35mm thick shutters & 150mm for 40 and 45mm shutters. The body shall be cast in one piece and fixed to cover plate by brass or M.S screws. On the extreme end there shall be rubber cushion to absorb shocks. The extension of the door stopper shall be in flush with floor and be finished bright/satin/chromium plated or anodised.

9.9 Hooks and Eyes

These shall be of mild steel or hard drawn brass and shall generally conform to IS : 207-1964.

9.10 Casement Window Handles
These shall be made of cast brass, steel protected against rusting, aluminium, pressed brass or as specified. Casement handles for single leaf window shutter shall be left or right handed and shall weigh as specified.

9.11 Casement Peg Stays

These shall be made of cast brass, steel protected against rusting, aluminium, cast alloy or as specified. The stay shall be made from a channel section and shall be 300mm long with steel peg and locking bracket. The peg stay shall have three holes to open the window in three different angles. The shape and pattern of stays shall be approved by the Engineer. The peg stay shall be minimum 2mm thickness in case of brass and aluminium and 1.25 mm in case of steel.

9.12 Quadrant Stays

These shall be made of cast brass, aluminium alloy, CP iron or as specified. The shape and pattern shall be approved by the Engineer. It shall weigh as specified.

9.13 Fan Light Pivots

These shall be made of mild steel, cast brass or aluminium alloy or as specified and shall generally conform to IS : 1837-1966.

The pattern and the shape of the catch shall be as approved by the Engineer and size and finish shall be as specified.

9.14 Fan light catch

These shall be made of mild steel, cast brass, aluminium alloy or as specified and shall generally conform to IS : 364-1993. Steel springs of the catch shall be 0.90 mm dia, 6 coils, 12 mm internal diameter and 20 mm long. The pattern and the shape of the catch shall be as approved by the Engineer.

9.15 Steel Frames

These shall conform to IS:4351-1976. The frames shall be manufactured from commercial mild steel sheets of 1.25mm thickness and are suitable for door shutters 30 to 40mm thick. The door frames are designated as per profile A, B and C.

Profile A Size 105x60mm : rebated for one set of shutters
Profile B Size 125x60mm : rebated for one set of shutters
Profile C Size 165x60mm : rebated for two sets of shutters.

Miscellaneous Items :

9.16 Putty

The material shall be homogeneous paste and shall be free from dust and other visible impurities. Putty shall conform to IS : 419-1967 for wood work.

10.0 METAL DOORS, WINDOWS, VENTILATORS AND ROLLING SHUTTERS

10.1 General
Materials used in the fabrication of doors, windows, and ventilators shall be the best procurable and conforming to relevant Indian Standards.

10.2 Steel Doors, Windows and Ventilators

Steel sections used for fabrication of doors, windows and ventilators shall be standard rolled steel sections specified in IS : 1038, IS : 1977, IS : 1361 or IS : 7452 year 1983, 1975, 1978 and 1990 respectively as appropriate or as specified in drawing and Schedule of Items. Rivets shall conform to IS : 1148-1982.

10.3 Aluminium Door, Windows and Ventilators

Aluminium sections for fabricating doors, windows, ventilators, partitions etc., shall be extruded sections conforming to IS : 1948-1961 & IS : 1949-1961 or as manufactured by Indian Aluminium Company Limited or approved equivalent. The alloy used shall conform to Designation HE 9 - WP of IS : 733-1983. As far as possible Sliding type Aluminium windows shall be used in office buildings.

10.4 Steel Rolling Shutters, Rolling Grills

DELETED

In this project Flap type, sliding type steel shutters shall be used.

10.5 M.S. Bolts etc.

M.S. bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated for corrosion. Putty for glazing shall conform to IS : 419-1967. Glass panes and glazing shall conform to the specification detailed under this series.

10.6 Hardware and fixtures shall be as specified in the drawings or Schedule of Items. All hardware and fixtures shall be able to withstand repeated use. Door closers shall be suitable for doors weighing 61 - 80 kg, unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements and endurance test stated in IS: 3564 1986 Appendix-A.

10.7 The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall conform to IS : 1081-1960 and/or as approved by the Engineer.

11.0 GLASS

11.1 General

Plain, ground, frosted or rough cast wired glass shall be used as shown on the drawing or as specified in the Schedule of Items. It shall be procured from a reputed source of manufacture and be of the best quality. All glass panes shall be free from flaws, specks, bubbles etc. Glass panes shall be of thickness 3mm or more as required. Weight of 3mm thick glass pane shall not be less than 7.5 Kg/sqm. The tolerance of glass panes, except wired glasses, in length and width shall be plus or minus 2 mm for 3 to 6.3 mm glass sheets. Tolerance in thickness of glass sheets shall be +/- 0.2mm for 3mm and 4mm thick glasses and +/- 0.3mm for 4.8, 5.5 and 6.3mm thick glasses.

11.2 Plain Transparent Glass
Plain transparent glass for glazing and framing shall conform to IS: 2835-1987. It shall be free from flaws, specks, bubbles or distortions.

11.3 Ground and Frosted Glass

Glare reducing or heat absorbing glass shall be “Calorex” or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

11.4 Thickness

Glass shall have the following thickness, unless otherwise stated in the Schedule of Items or drawings:

- Upto 60 cms x 60 cms: 3 mm
- Do- of larger size: 4 mm and 4.8 mm
- Sheet glass for doors: 5.5 mm
- Rough cast wired: 6.4 +/- 0.4 mm

11.5 Inspection

All glasses shall be subject to inspection on the site. Glass found to suffer from defects shall be rejected. Samples submitted for inspection shall be selected so as to be representative of the consignment.

12.0 PAINTS

12.1 General

All paints, varnishes, distemper or other surface coating materials shall be of approved quality conforming to the appropriate Indian Standard, wherever such standard is available, and be obtained from a manufacturer of repute. If there is more than one quality for one particular product, only first quality shall be used unless otherwise stated in the Schedule of Items.

12.2 Sampling and Testing

The Engineer may, at his discretion, require samples of paint to be tested. In such cases testing will be according to IS: 101 (Part 1 to 8) -1964 to 1993.

12.3 Storage

Paints, primers, distempers and varnishes shall be delivered in sealed containers. They shall be stored in cool dry condition to the satisfaction of the Engineer.

12.4 Paints for Priming

Readymixed paints for priming coats of steel and iron work shall either comply with IS: 2074-1992 "Ready Mixed Paint", "Red Oxide Zinc Chrome Priming" or Red Oxide metal primer as specified. For wood work it shall be pink/white wood primer as specified by the manufacturer of the synthetic enamel paints, conforming to IS: 3536-1966.

12.5 Paints for finishing

Readymixed oil synthetic enamel paint of approved manufacturers like Berger, Jenson & Nicholson, Shalimar, I.C.I., Asian, Garware and Goodlass Nerolac paints only shall be
used unless otherwise specified. Paint shall be of first grade quality of the above manufacturers ie., Luxol Brolac, Superlac, Dulox gloss, Apocolite, Garcoat and Nerolac respectively.

If for any other reason, thinning is necessary, the brand of the thinner recommended by the manufacturer, shall only be used with the specific permission of the Engineer.

Aluminium paint for general purpose shall be in Duel Containers. It shall be of manufacturers as for synthetic enamel paints above.

12.6 White wash

White was shall be prepared from freshly burnt fat, white in colour lime slaked on spot, conforming to IS : 712-1984 mixed and stirred with sufficient water to make a thin cream. Best and approved quality gum and ultra marine blue only shall be used in lime wash.

12.7 Colour wash

Colour wash shall be prepared by adding mineral colours, not affected by lime, to white wash.

12.8 Water proofing Cement Paint

DELETED

In this project exterior emulsion paints of reputed make like Berger, Jenson & Nicholson, Asian, Shalimar, Garware Goodlass Nerolac & Snowcem as per manufacturers specifications only to be used. The shade shall be approved by the Engineer before application of the paint and shall comply with relevant standards and specifications.

12.9 Distemper

DELETED

Dry synthetic distemper shall be replaced by Acrylic washable distemper

Only plastic emulsion /interior emulsion paints of of reputed make like Berger, Jenson & Nicholson, Asian, Shalimar, Garware Goodlass Nerolac & Snowcem as per manufacturers specifications only to be used in office and other rooms as per the requirement of Client. The shade shall be approved by the Engineer before application of the distemper and shall comply with relevant standards and specifications.

12.10 Varnish

Varnish for the finishing coat shall be copal finish or synthetic class varnish of approved brand. Varnish for the under coat shall be flatting varnish of the same make as the top coats and shall be to the satisfaction of the Engineer.

12.11 Polish

French spirit polish shall be of an approved make conforming to IS: 348-1968. In case it is to be prepared on site, the polish shall be made by dissolving 0.7 kg of best, shellac in 4.5 litres of methylated spirit without heating. To obtain required shade pigment may be added and mixed. Shallac shall conform to IS : 5467-1986.
12.11.1 Wax polish for Wood work

The polish shall consist mainly of waxes and Organic solvents with or without water and shall be of smooth consistency, homogeneous, Semi-Solid mass and free from gritty materials. It shall not flow at ordinary temperature. It may be tinted with an oil soluble colour. The polish shall not crumble or dry too rapidly and shall produce non-tacky polished surface. The polish shall be amenable to smooth spreading on the furniture surface and the gloss shall appear on gentle rubbing with a soft polishing cloth.

The wax polish shall conform to IS : 8542-1977.

12.11.2 Where wax polishing is to be prepared at site, it shall be prepared by heating two parts of "Bee Wax" two parts of boiled linseed oil over a slow fire. When dissolved but still warm, one part of turpentine is to be added. The boiled linseed oil, bees wax and turpentine used shall be of approved quality and complying with IS : 77-1976, IS : 1504-1974 and IS : 533-1973 respectively.

12.12 Plastic (Acrylic) emulsion paint

Plastic emulsion paint of approved manufacturers like Jenson & Nicholson, Goodlass Nerolac, Shalimar, Berger, Asian and Garware paints only shall be used unless otherwise specified and shall comply with IS : 5411 (Part 1)-1974 & (Part 2)-1972 as applicable. Cement primer used for priming work both for oil bound distemper and plastic emulsion paint shall be of the same manufacture as that of distemper or plastic emulsion paint used. For dry distemper priming, whiting of approved quality shall be used.

12.13 Creosote oil or Coaltar Creosote

It is primarily used for preservation of wood. It shall be a homogeneous liquid and shall liquefy completely on being warmed to 38 degree C with stirring and shall remain liquid on cooling down to 32 degree C and on standing at that temperature for 2 hours.

The material shall conform to IS : 218-1983. All persons handling the creosote oil should be fully aware of the hazards involved in handling. Skin should be protected from coming in direct contact and eyes should be protected by using safety goggles while handling the material.

12.14 Coal tar Black Paint

Coal tar paint film protects surfaces by serving as a barrier against the action of moisture and other corrosive agents. Coal tar black paint is generally used as a protective and anti corrosive paint of iron and steel as well as protection of other building surfaces. For this it has to be applied under proper condition and on suitably prepared surface. Coal tar should be applied by brush only and is not recommended for locations which are not likely to be well ventilated. Coal tar paint shall conform to IS : 290 1961.

The material is of two types : Type A Quickly drying and Type B Slow drying. It shall be a homogenous black solution type paint consisting of a base prepared by blinding suitable grades of Collar pitch, washed free from ammoniacal liquor, tar acid bases etc. Consistency, permeability, thickness and surface preparation etc. shall be as per para 5 and A-2 of the above code.

12.15 Floor Polish - Paste

The polish shall consist mainly of waxes and organic solvents with or without water.
The paste floor polish shall be of smooth consistency, homogenous, semi-solid-mass and free from gritty material. It shall not flow at ordinary temperature. It shall be so constituted and prepared that on application by means of a clean cloth, it shall spread easily and evenly and shall give with minimum buffing a firm and glossy surface free from greasiness or tackiness. The polish film after spreading with a cloth shall not take more than 10 minutes to dry. The polished floor shall neither be slippery nor show any resistance to easy walking.

Floor polish paste shall conform to IS : 8591-1977.

12.16 Exterior emulsion / acrylic paint

Exterior emulsion/acrylic paint of approved brand and manufacture like Snowcem India Limited, ICI, Asian Paints, Berger Paints. The shade shall be approved by the engineer before its application.

13.0 WATER PROOFING MATERIALS

13.1 Integral Cement Waterproofing Compounds

Integral cement waterproofing compounds, i.e. admixture for waterproofing purposes shall fully comply with the requirements of IS : 2645-1975. Properties like permeability, setting time, compressive strength shall be in accordance with the requirements of this code when tested as per procedure laid therein. Calcium chloride content of the product used shall be made known to Engineer before use.

13.2 Bitumen

The bitumen bonding material for waterproofing shall conform to the requirements laid down in IS : 702-1988 or IS : 93-1992 or IS : 217- 1988 or IS : 454-1961 depending upon whether industrial bitumen, paving bitumen or cutback bitumen is used. For selecting the particular type and grade of bitumen to be used the relevant item in Schedule of Items shall be referred to.

13.3 Bitumen Primer

Bitumen primer used for application to concrete and masonry surfaces and bitumen for the purpose of waterproofing shall conform to requirements given in IS : 3384-1986 and pass tests in accordance with the procedure laid down in appropriate IS mentioned in Table-I of IS : 3384-1986. Bitumen primer should be free from water and shall preferably be made from the same grade of bitumen as used in bonding.

13.4 Bitumen Felt

DELETED.

13.5 Bitumen Mastic

Bitumen mastic used for water proofing of roofs shall have the physical properties as mentioned in IS : 3037-1986 when tested with the procedure laid down in appropriate IS mentioned in IS : 3037-1986.

13.6 Bituminous Compounds
13.7 Surface Application Materials

Waterproofing material for application on mortar or concrete surface shall conform to IS: 9862 1981. The primer shall be suitable for spray or brush application. It shall have properties enabling it to penetrate through pores or cracks and fill them up, making the surface impervious.

13.8 Polymer based paints

The materials used shall be high polymer based chloride and sulphide free cement and waterproofing additions and epoxy based waterproofing paints as per manufacturer's specification and approved by Engineer.

13.9 Fibre glass R. P. Tissue

The fibre glass R.P. tissue is a thin flexible uniform mat, composed of glass fibre in an open porous structure bonded with a suitable inert material compatible with coal tar, asphaltic enamel and oil plastic based wall paint. The fibrous glass mat is reinforced with continuous filament glass yard at 3/8" (10mm) pitch in the longitudinal direction.

PHYSICAL PROPERTIES

i) Weight
   The average weight of fibre glass R.P. tissue shall not be less than 50 gms/sq.sm.

ii) Thickness
   The fibre glass R.P. tissue shall have a thickness not less than 0.4mm.

iii) Tear Strength
    The tear strength shall be not less than 900 grams in the transverse direction.

iv) Breaking Strength
    This shall have a minimum breaking strength of 13 lb/in (2.32kg/cm) in the longitudinal direction.

v) Porosity
   This shall have a porosity when related to pressure difference across the sample of not less than 0.022” (0.56mm) and not more than 0.76” (1.92mm) of water guage at an air velocity of 200fpm.(100cm/sec.).

vi) Pliability
   There shall be no cracking of the tissue mat when bent over a 1/8” (3.2mm) radius after immersing for 10-15min. through a 90 degree arc.

vii) Temperature
    The fibre glass tissue shall be Resistance under a load of hot bitumen at 530 degree F (276 degree C) for one minute.

13.9.1 Primer

Primer shall conform to requirements laid down in IS : 3384-1986. It is to be prepared by blending turpentine and blown grade bitumen in the ratio of 60:40 by weight.

13.9.2 Blown Materials
Blown grade bitumen shall be conforming to IS : 702-1988 and residual grade bitumen conforming to IS:73 respectively. This shall be prepared by heating to correct working temperature.

13.9.3 Surface finish
Pea sized gravel/grit 6mm and down.

13.10 P.V.C. Membrane/Sheets
Membrane type water proofing either PVC or APP of reputed make like CICA,CICO shall only be used in this project and applied as per manufactures specifications.

Polyvinyl chloride sheets for the purpose of water proofing and other underground use are specially developed sheets made from the compounded resin of grade MP/DP/CR-02 and shall be resistant to the passage of gross water and water vapour. It shall be corrosion resistant and resistant to a wide range of acidic and alkali reagents, saltpetre action, salt water and ultra violet rays etc. PVC sheets manufactured by approved and reputed firms like Maxlok Polymer Ltd. shall only be used.

The sheets shall consist of Knobs or Lugs jutting out of the sheets in a grid fashion so as to provide a perfect grip in the mortar and concrete. Sheet thickness, spacing of the knobs and their projection from the sheet shall be as specified in the item. The sheets shall be of maximum practicable length and width unless otherwise specified.

The adhesive used for jointing shall be of approved quality and of grade C-02.

The sample of the material shall be got approved before use.

13.10.1 Properties

i) Chemical Composition : Resin Plasticiser Inhibitor Stabiliser UV Barrier.
ii) Thickness : Not less than 0.25 mm
iii) Rupture/Tensile Strength : Not less than 225Kg/cm²
iv) Adhesive bond Strength [width] : Not less than 7.1 Kg/cm
v) Elongation at Break : 130%

14.0 WATER BAR

14.1 General
Water bar for use in construction/expansion joints in concrete and reinforced concrete structures shall be of copper sheet, galvanised steel sheet, rubber or PVC as shown in drawing or described in the Schedule of Items. It shall be subject to approval of Engineer.

14.2 Jointing
The water bar shall have dimensions as shown in drawing. Where water bars are required to be lengthened or otherwise jointed the joining shall be done in such a way as to achieve a perfectly watertight joint.

15.0 LEAD

15.1 General

Lead for joints in cast iron spigot and socket pipes shall be melted from pure soft pig lead conforming to Type-I of IS : 782-1978. "Caulking Lead". Where lead wool is allowed for caulking, it shall be equal to or better than Type-II of IS : 782-1978. Lead flashing shall conform to IS : 405 Part I&II-1992.

16.0 BUILDING PAPER

16.1 Building paper shall be bitumen impregnated paper conforming to IS: 5134 1977, or such other as may be approved by the Engineer.

17.0 FILLING MATERIAL

17.1 General

Filling material shall conform to what is shown in drawing, described in the Schedule of Items or otherwise directed by the Engineer. Earth or sand for filling under floors shall correspond to those described elsewhere in these specifications.

17.2 Mastic Bitumen

Mastic Bitumen shall conform to IS : 3037-1986 or IS : 5871-1987 as appropriate.

17.3 Flexible Boards

Flexible boards for use in expansion joints shall correspond to the description given in drawing or the Schedule of Items or the instruction of Engineer.

18.0 DRAINAGE & SANITATION (INTERNAL)

18.1 General

All materials, pipes, specials, fittings, fixtures etc., to be used in the works shall be of best quality and class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from manufacturer or their accredited stockists and be marked with manufacturers' names and trade mark. Contractor shall submit to the Engineer samples of all materials, pipes, specials, fittings fixtures for approval before use in the works. Such approved samples shall be retained by the Engineer till completion of works. Pipes and Specials may be any or combination of following types:-

i) PVC Pipes for rain water
ii) Stone Ware Pipes
iii) Sand Cast Iron Pipes for soil waste & Ventilation
iv) CI Pipes for rain water
v) AC Pipes for rain water
vi) R.C.C Pipes

18.1.1 High density PVC pipes and fittings
All rain water pipes with fittings to be used in this project shall be of High density PVC confirming to relevant standards. This shall conform to IS : 4984-1987 and IS : 8008 (Part 1 to 7)-1976 unless otherwise specified.

18.2 PVC Waste Pipe

This shall conform to IS : 4985-1988 unless otherwise specified.

18.3 Stoneware Pipes & Fittings

All stoneware pipes, bends, gully traps and sewer traps shall be of the best salt glazed variety inside and outside, hard burnt dark grey colour, perfectly sound, free from fire cracks and imperfection of glaze, truly circular in cross section, perfectly straight, of standard nominal length and depth of socket and barrel. These shall be of approved manufacture and shall comply with the requirement of IS: 651-1992. These pipes shall be of grade AA unless otherwise specified.

18.4 Sand Cast Iron Pipes & Fittings conforming to IS : 1729-1979

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS: 1729-1979. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior of the pipe and fittings shall be clean, smooth painted inside and outside with DR Angas smiths solution or other approved anti-corrosive paint.

The standard weights and thickness of pipe shall comply with the requirements of IS: 1729-1979. The tolerance on wall thickness and weight shall be minus 15 percent and minus 10 percent respectively. Pipes weighing more than the nominal weight given below may be accepted provided they comply in every other respect.

<table>
<thead>
<tr>
<th>Nominal size</th>
<th>Weight per piece in Kg. excluding ears Overall length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1500 mm</td>
</tr>
<tr>
<td>50</td>
<td>9.56</td>
</tr>
<tr>
<td>75</td>
<td>13.83</td>
</tr>
<tr>
<td>100</td>
<td>18.14</td>
</tr>
<tr>
<td>150</td>
<td>26.70</td>
</tr>
</tbody>
</table>

Specials and Fittings shall include bends, offsets, branches of various types, junctions etc., as required for the work which shall be provided according to drawings and directions of the Engineer. B.M. trap shall have water seal as per I.S. provisions.

The specials and fittings shall be provided with access doors where so specified or directed by the Engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3 mm thick rubber insertion packing, and when closed and bolted they shall be water tight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

18.5 Cast Iron Pipes & A.C. pipes : Rainwater pipe

DELETED

18.6 Sanitary appliances
Sanitary appliances like I.W.C/E.W.C pans, wash basin, urinals and sinks etc. shall be made of vitreous china or fire clay as specified. These shall be of Hindustan Sanitary ware or Parry ware make unless otherwise specified and to be approved by the Engineer. These shall conform to A class quality of IS : 2566 (Part 1 to 15)-1972 to 1985 and IS : 771 (Part 1 to 15) –1979 & 1985 respectively.

18.6.1 **European Pattern W.C.**

Unless otherwise specified, these shall comprise of :

a) White 'glazed earthenware wash down closet set with 'S' or 'P' trap of standard size.

b) 'Duco' spray painted 12.5 litres mosquito proof low level M.S or C.I flushing cistern with valveless siphon, 15 mm ball cock, C.P. brass unions & couplings for the 32 mm dia flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.

c) 'Duco' spray painted 1 1/4" (32 mm) dia G.I. telescopic flush pipe with buffer clamp, holder bat clamp and 38mm dia PVC pipe or 35/40mm O.D. high density polythene flush pipe with buffer clamp, holder bat clamp.

d) Approved quality solid plastic W.C. seat and cover, bar hinges, screws bolt, rubber buffers conforming to IS : 2548 (Part 1&2)- 1983.

e) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass CP cock.

f) Hard wood wooden blocks or other suitable fixing arrangement with screws and detofix for fixing WC in floor and putty joint with flush pipe and soil pipe.

18.6.2 **Indian Pattern W.C.**

Unless otherwise specified these shall comprise of :-

a) White glazed earthenware WC pan back entry type.

b) White glazed earthenware 'P' or 'S' trap with or without vent.

c) 12.5 litres approved make mosquito proof M.S.high level flushing cistern with valveless siphon, 15 mm ball cock, galvanized iron chain handle, cast iron brackets with wall plugs, brass unions and couplings for flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

d) 32 mm dia GI telescopic or 35/40 mm O.D high density PVC flush pipe with holder bat clamps.

e) One pair of white glazed earthen ware foot rest set in cement mortar 1:3.

f) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass stop cock.

18.7 **Wash Hand basin**

Unless otherwise specified these shall comprise of :-
a) White glazed earthenware basin with 2 nos. Concealed Cast Iron Brackets with wall plugs.
b) 1 no. 15 mm C.P. brass pillar tap.
c) 32 mm C.P. brass waste fitting, C.P. brass chain and rubber plug.
d) 32 mm PVC waste pipe with brass couplings/32 mm C.P. bottle trap.
e) 15 mm PVC connection pipe with brass couplings and 15 mm brass stop cock.

18.8 Flat Back Lipped Urinal

DELETED

Long pattern type urinals are envisaged in this project

Flat Back Large Urinal

Unless otherwise specified these shall comprises of:

i) White glazed earthenware urinal basin flat back large type
ii) Urinal flush valve auto closing system (pressmatic) with C.P. spreaders and connection pipe with wall clips & brackets
iii) 32mm C.P. brass outlets complete with PVC waste

18.9 Mirror Frames

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make.

18.9.1 Mirror shall be of superior glass with edges rounded off or leveled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.0 mm. The glass for the mirror shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.

18.10 Toilet Shelf

18.10.1 Glass shelf unit shall consist of an assembly of glass shelf, anodised aluminium / CP brass guard rail and supporting brackets. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws, specks, bubbles and of thickness not less than 5.0 mm. The shelf shall have guard rail, resting on rubber washers on glass plate.

18.10.2 Ceramics shelf shall be of shape, size and design as specified in the Schedule of Items.

18.11 Towel Rail

Towel rail shall be of CP brass / anodised aluminium with two brackets of same material, diameter and length as specified.

18.12 Soap Container

Soap container shall be of C.P brass, PVC with cp brass brackets of approved make and design.
18.13 **CP Flush Valves for EWC**

The CP flush valve for EWC shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asia Continental Metallwaren Fabric or equivalent quality.

18.14 **CP Flush Valve for Urinals**

CP flush valve for urinal shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asian Continental Metallwaren Fabric or of equivalent quality.

18.15 **Gully Trap**

Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight pre-cast R.C. cover 300 x 300 x 40 mm thick with 1:1 1/2:3 mix concrete (one cement: one and half sand : 3 stone chips 20 mm down) including neat cement finish.

18.16 **CI Manhole Covers & Frames**

These shall be of light or medium duty (LD or MD) as specified in Schedule of Items and of cast iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material. Light duty covers and frames shall be of either rectangular type, single seal, pattern 1 and 2 having minimum weight of cover and frame 38 Kg and 25 Kg. respectively or with double seal, minimum weight of cover and frame being 52 Kg. These may be of square type also. Single seal with clear openings of 455 and 610 mm with minimum weight of cover and frame being 20 Kg and 38 Kg respectively, double seal of same openings shall have minimum Wt. of cover and frame 30 Kg and 55 Kg respectively. Medium duty covers and frames shall be either of circular type with 500 and 560 mm clear openings and minimum Wt. of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum Wt. of cover and frame 144 Kg.


18.17 **Flushing Cisterns**

Manually operated high level and low level flushing cisterns are of 5 litre and 10 litre capacities, both single flush and dual flush type. The cisterns shall conform to IS : 774-1984 and be made of Cast Iron, Vitreous China or enamelled pressed steel. The cisterns shall be mosquito-proof.

The thickness of the body including cover shall be not less than 5 mm for Cast Iron and 6 mm for Vitreous China Cisterns. Steel and lead flush pipe shall have internal diameter of 32 plus or minus 1 mm for high level cisterns and 38 plus or minus 1mm for low level cisterns. For high density polyethylene and unplasticised PVC pipes the outside diameter of the pipe shall be 40 mm. In case of PVC plumbing pipes the outside diameter of the pipes shall be 40mm for high level and 50mm for low level cisterns. Steel flush pipes shall be hot dip galvanized electroplated or vitreous enameled.


Cast Iron Cisterns shall be painted and finished in accordance with recommendation made in IS : 1477 (Part 1&2)-1971 or shall have a coating of enamel.

In general, Materials Construction and operational and performance requirements shall be as specified in para 3, 4 and 6 of IS : 774-1984.
18.18 Plastic Seats & Covers for Water Closets

These shall conform to IS : 2548 (Part 1&2)-1983 and shall be either of thermo-set or of thermo-plastic quality.

Thermo-set Seats and Covers are moulded from phenolic plastics (Type A) or Urea Formaldehyde (Type B). Thermo-plastic Seats and Covers are also of Type A, moulded from Polystyrene or Type B, moulded from Polypropylene.

Underside of the seats may be either flat or recessed and colour shall be as agreed. Table Dimesions of the seats and covers shall be as per Table-I of the Code (both Part 1&2). Hinging device may be either of the following materials:

i) Bronze or Brass with Nickel Chromium Plating
ii) Mild Steel with Nickel Chromium Plating
iii) Aluminium alloy with anodic coating
iv) Suitable plastic with reinforcement.

19.0 WATER SUPPLY & PLUMBING (INTERNAL)

19.1 General

This section deals with the specification of material for pipes, fittings, fixtures etc., to be used in water supply works.

All materials, pipes, fittings, fixtures to be used in the works shall be of the best quality and of the class specified in various clauses herein under. Where specified these shall be of specific manufacture and quality and shall be procured from the manufacturer or their accredited stockist and be marked with manufacturers name and trade marks. The Contractor shall submit to the Engineer samples of all pipes, fittings, fixtures for approval before being used in the works. Such approved samples shall be retained by the Engineer till completion of works.

Pipes and pipe fittings may be of any or combination of following types:

i) Wrought iron galvanised pipe
ii) PVC pipes
iii) Cast iron pipes
iv) Steel pipes coated with bitumen composition inside and galvanised outside.

v) Reinforced concrete pipes
vi) Asbestos cement pipes
vii) Pre-stressed concrete pipes
viii) Lead pipe (not to be used for potable water)

19.2 Galvanised Iron Pipes and Fittings
DELETED

In this project Polyethylene-Aluminum-polyethylene pipes as per IS 15450:2004 shall be considered.

19.3 R.C.C, Asbestos, Pre stressed Pipes and Fittings


19.4 Cast Iron Pipes and Fittings

The cast iron pipes shall be of approved manufacture and quality and shall conform to IS: 1536  1989 "Centrifugally Cast (Spun) iron pressure pipe and/or IS : 1537  1976". Vertically Cast Iron pressure pipe for water, gas and sewage. CI fittings shall conform to IS : 1538 (Part 1 to 23) 1976.

19.5 Steel Pipes

This shall conform to IS: 1239 (Part 1&2)  1990 to 1992) and IS : 3589- 1991. Steel pipes shall be coated with bituminous composition inside and galvanised outside.

19.6 Bib Tap and Stop Tap

Bib tap and stop tap for water services shall be of brass screw down type and shall conform to IS: 781. Minimum finished weight of bib and stop taps shall be as given below:

<table>
<thead>
<tr>
<th>No. of size (mm)</th>
<th>Bib taps (kg)</th>
<th>Stop tap (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>0.40</td>
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<tr>
<td>20</td>
<td>0.75</td>
<td>0.75</td>
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<tr>
<td>25</td>
<td>1.25</td>
<td>1.30</td>
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<tr>
<td>32</td>
<td>-</td>
<td>1.80</td>
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<td>40</td>
<td>-</td>
<td>2.25</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>3.85</td>
</tr>
</tbody>
</table>

The taps shall be tested under internal hydraulic pressure of at least 20 kgf/cm2 and maintained at the pressure for a period of at least two minutes during which period it shall neither leak nor sweat.

19.7 Valves

Unless otherwise mentioned in the Schedule of Quantities these shall be copper alloy gate, globe and check valve of nominal sizes 8 to 100mm and shall conform to IS : 778 1984. Valves shall be of class 1 and class 2, suitable upto a temp. of 45 degree C and can sustain non shock working pressure upto 1.0 and 1.6 MPA respectively. They shall have screwed or flanged ends. All the metal parts shall be of brass/brass alloy except hand wheel of Cast Iron or other approved quality.

19.8 Shower Rose
The shower rose shall be of heavy quality chromium plated brass with flat bottom, of diameter 100 mm or as specified with uniform perforations.

19.9 Storage Tank

Storage tank shall be either pressed steel, Galvanised iron, R.C.C or PVC of specified sizes, capacities, make, manufacture as specified in Schedule of Items. It shall have facilities for connecting inlet, outlet overflow and washout pipes and a top cover. Where tanks are to be fabricated by the Contractor the fabrication/R.C.C detailed drawings shall be got approved by Engineer.

19.10 Miscellaneous items

19.10.1 Half round channel

This shall be made of vitreous china channel with or without outlet/stop end as specified in Schedule of Items and shall be of approved manufacture.

19.10.2 Urinal partition

This shall be made of marble or granite and shall be of approved make and quality shade and texture

20.0 EXTERNAL SEWERAGE & DRAINAGE

Unless otherwise specified CI pipe and specials, caulking lead, SW pipe, RCC pipe shall conform to the following.

20.1 C.I. Pipes

i) C.I. pipe shall conform to IS : 1536 - 1989 or/and IS : 1537 – 1976 of class as specified in Schedule of Items.

ii) C.I. pipe fittings shall conform to IS : 1538 (Part 1 to 23) -1976 as specified in Schedule of Items.

iii) Bolts and nuts shall be hexagonal bolts and nuts conforming to IS : 1363 (Part 1 to 3) - 1992.

20.2 Washers

Spring washers conforming to IS : 3063 - 1972 shall be used near the pumps to take care of vibration. In other places plain washers conforming to IS : 2016 - 1967 shall be used.

20.3 Gaskets

Gaskets shall be reinforced rubber sheet or compressed fibre board conforming to IS : 638 - 1979 of thickness between 1.5mm to 3mm or as specified.

20.4 Caulking Lead

Lead for the spigot and socket joints shall conform to IS : 782 - 1978.

20.5 Salt Glazed Stone Ware Pipes

Salt glazed stone-ware pipes used shall conform to IS : 651 - 1992 and shall be laid as per IS : 4127 - 1983. The pipes shall be of grade AA unless otherwise specified.
20.6 Steel Pipes

Steel pipes and fittings used for encasing shall conform to IS : 1239 (Part 1&2) - 1990 to 1992 medium Class upto 150 mm dia and as per IS : 3589 - 1991 for pipes of dia 200 mm and above. For pipes of dia 200 mm and above fittings, if required shall be fabricated from pipes itself.

20.7 Cast Iron Manhole Covers & Frames

These shall be of medium or heavy duty (M.D. or H.D.) as specified in Schedule of Item and of Cast Iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material. Medium duty covers and frames shall be either of circular type with 500 mm clear opening and minimum weight of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum weight of cover and frame 144 Kg. Heavy duty covers and frames shall be either of circular type with clear openings of 500 and 560 mm and 170 and 208 Kg weight respectively or of double triangular type with clear openings of 500 and 560 mm and 229 and 255 Kg weight respectively.

The CI manhole cover and frames shall conform to IS : 1726 - 1991.

21.0 ROAD

21.1 General

Roads in this project shall be of RCC confirming to relevant standards.

21.2 Soling Stones

Material for soling shall be natural stone boulders or crushed blast furnace slab. Stones for soling shall be of height equal to thickness of the soling with tolerance of plus or minus 25mm and shall not have a base area of less than 250 sq.cm. nor more than 500 sq.cm. and the smallest dimension of any stone shall not be less than half the largest dimension. Stones shall be tough, angular, durable and generally free from flat, elongated, soft and disintegrated particles. They shall also be free from dirt or other objectionable matter and be obtained from quarries approved by the Engineer.

Crushed slag obtained from air-cooled blast furnaces slag shall be angular, of reasonably uniform quality and density and generally be free from any thin, elongated, and soft pieces, dirt or other objectionable matter. The density of slag should not be less than 1.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS:2386 (Part-III) - 1963. "Methods of Tests for Aggregates for Concrete : Specific Gravity, Density Voids, Absorption and Bulking", shall not exceed 10%.

21.3 Coarse Aggregate for Water Bound Macadam

Coarse aggregate for water bound macadam shall be natural gravel, crushed stone obtained from approved quarries or crushed blast furnace slag. Crushed stone shall be hard, durable, tough and of uniform quality, generally free from flat, elongated, soft and disintegrated particles. It shall have sharp edges and also not have excess of dirt and other objectionable matter. When tested as per IS: 2386 (Part-IV) - 1963 for Los Angeles Abrasion Value or Aggregate Impact Value, the limiting values shall be 50% and 40% respectively for base course and 40% and 30% respectively for surfacing course. The flakiness index shall not exceed 15% when tested in accordance with IS: 2386 (Part-I)-1963 "Methods of Test for Aggregates for Concrete : Particle size and Shape". Crushed slag aggregates shall meet the requirements given for soling stones from blast furnace slag.
Size and grading requirements of coarse aggregates shall be as specified in Table-2 of IRC : 19 - 1981, "Standard Specification and Code of Practice for Water Bound Macadam". The grading number of the table shall correspond to the following layer thicknesses:

<table>
<thead>
<tr>
<th>Grading Number</th>
<th>Size Range</th>
<th>Layer Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90 mm to 40 mm</td>
<td>More than 90 mm</td>
</tr>
<tr>
<td>2</td>
<td>63 mm to 40 mm</td>
<td>90 mm to 75 mm</td>
</tr>
<tr>
<td>3</td>
<td>50 mm to 20 mm</td>
<td>75 mm to 50 mm</td>
</tr>
</tbody>
</table>

21.4 Screenings

Screenings used for filling voids in coarse aggregates for water bound macadam shall generally be of the same material as the coarse aggregate. Non-plastic materials such as Kankar nodules, moorum or gravel (other than river bore rounded aggregates) may be used, provided that the liquid limit and plasticity index are below 20 and 6 respectively. The fraction passing 75 microns sieve shall not exceed 10%. Size and grading of screenings shall be as specified in Table-3 of IRC-19 - 1981. Type-A screening shall be used for grade number 1 coarse aggregate. Type-B screenings shall be used for grade number 3. Either Type-A or Type-B screenings may be used for grade number 2.

21.5 Stone Chips for Bituminous Surfacing

Coarse aggregate shall consist of crushed stone, crushed slag or crushed gravel (Shingle) retained on 2.36 mm sieve. The aggregates shall be clean, strong, durable and fairly cubical, free from disintegrated pieces, organic and other objectionable matter. The aggregates shall preferably by hydrophobic and of low porosity. The mechanical properties and grading shall be in accordance with IRC-29 - 1988 "Tentative Specifications for 4 cm Asphaltic Concrete Surface Course", having aggregate impact value 30%, Flakiness Index 25% and graded between 20mm and 2.36 mm.

21.6 Sand

Sand for use as fine aggregate in bituminous surfacing shall consist of crushed screenings, natural sand or a mixture of both, passing a 2.36mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, uncoated and dry, free from injurious, soft or flaky pieces and organic deleterious substances.

21.7 Binder

Binding material for water bound macadam shall consist of fine grained material such as stone dust, kankar modules or moorum. The plasticity index shall be between 4 to 9 when water bound macadam is to be used as surface course and upto 6 when used as sub/base or base course.

21.7.1 Paving Bitumen

It shall conform to IS : 73 - 1992 and shall be of the specified type and grade. The material shall be homogeneous and shall not foam when heated to 175 degree C. Various properties like specific gravity, flash point, softening point, penetration etc. shall be as given in the above code.

21.7.2 Bitumen Cut Back

Bitumen cut-back shall conform to specification given in IS : 217 - 1988. It shall be of three types, Rapid Curing (RC), Medium Curing (MC) and Slow Curing (SC). These shall comply with the requirements specified in Table - 1, 2 and 3 respectively of the above code.
The above three types of cutback bitumens shall be classified into different grades on the basis of Kinematic viscosity. Rapid curing type shall be used with aggregates containing practically no fine aggregates passing through 2.36 mm sieve. Medium curing bitumen shall be used with aggregates containing less than 20 per cent of fine aggregates passing through 2.36 mm sieve. Slow curing type shall be used with aggregates containing more than 20 per cent of fine aggregate passing through 2.36 mm sieve.

Medium curing bitumen of 30 grade i.e. MC 30 shall be used as primer. Manufacturer shall indicate source and type of the bitumen.

21.8 Kerbs

Kerbs may be of stone, concrete or brick as may be shown in drawing or otherwise directed by Engineer.

21.8.1 Stone kerbs

Stones shall conform to the dimensions and shapes given in drawing.

Exposed faces shall be dressed to lines.

21.8.2 Concrete kerbs

Shape and dimension shall conform to the drawing. They shall be pre-cast and the road side top corner shall be given a chamfer.

21.9 Galvanized Steel Barbed Wire for Fencing

These shall be of two types A&B. In both types Barbs shall have 4 points formed by twisting two point wires, each two turns. In type A (Iowa type) twisting is done around both line wings and in type B (Glidden type) around one line wire, in both cases making altogether four complete turns. It shall conform to IS : 278 - 1978 and shall have the diameter of line and point wire as described in schedule of item. Galvanized mild steel wire shall conform to IS : 280 - 1978.

Line and point wire shall be circular in section, free from scales and shall be uniformly galvanized. Line wire shall be in continuous length and shall not contain any welds other than those in rod before it is drawn.

21.10 Galvanized Steel Chain Link Fabric

It will conform to IS : 2721 - 1979. It shall be of width, mesh and wire dia as per description of Item. For chain link fabric having width upto 2.00 M, of all mesh sizes, two line wires shall be provided. Whereas for width of 2.40 M and mesh size exceeding 50mm three line wires shall be provided. These shall be provided at top and bottom of the fabric, but wherever three line wires have been specified, these shall be provided at top, bottom and middle of fabric.

The mesh wire and line wire of the fabric shall be manufactured from Galvanised steel conforming to IS : 280 - 1978. It will have zinc coating of type medium as given in IS : 4826 - 1979. " Specification for Hot dipped galvanized coatings on round steel wires". Unless otherwise mentioned in the description of item fabric with both ends twisted shall be used.

The galvanised steel pipe posts shall consists of 80 mm and 50 mm nominal diameter. The pipe posts shall conform to IS : 1161 and shall be of medium grade and galvanised.

22.0 LIST OF MATERIALS OF APPROVED BRAND AND/OR MANUFACTURE
Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials as listed below, of only these brand names/Company’s names, which are mentioned in the approved list for civil, water supply and sanitary items thereon.

### A. BUILDING MATERIALS

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<th>Brands and Companies</th>
</tr>
</thead>
<tbody>
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<td>1. Tiles (Terrazzo Mosaic Plain)</td>
<td>Mehtab Tiles, “NITCO”Indore, Shriram Tiles. Ahmednagar &amp; any other approved brand conforming to IS : 1237 -1980</td>
</tr>
<tr>
<td>2. Flush Doors</td>
<td>Vidarbha Veneer Industries, Woodcrafts, Western India, Plywood, Kit Ply, Godavari Plywood, Art Plywood, National Plywood Industries Pvt. Ltd.</td>
</tr>
<tr>
<td>3. Plywood Products</td>
<td>IPM, Novopan</td>
</tr>
<tr>
<td>5. Rolling Shutters and Rolling Grills</td>
<td>Standard, Swastik, Diana, Hercules, Prabhat, Vinayagar</td>
</tr>
<tr>
<td>6. Aluminium Doors, Windows, Partitions</td>
<td>Godrej, Ajit India Alumilite, Aardee, Indal</td>
</tr>
<tr>
<td>7. Water Proofing Compounds</td>
<td>CICO, Impermo, Accoproof</td>
</tr>
<tr>
<td>8. Hardeners</td>
<td>Ironite, Ferrok, Hardonate</td>
</tr>
<tr>
<td>10. Redoxide (For IPS Flooring)</td>
<td>Shalimar, Blundel, Eomite</td>
</tr>
<tr>
<td>12. Pressed Steel Door and Window Frame</td>
<td>Shirke Polynorm, T.I. Frames, Madras; Mann, Jaipur; Chandan Metal Products, Baroda; Agew, Ahmedabad; Multiwyn, Calcutta.</td>
</tr>
<tr>
<td>15. Construction Chemicals</td>
<td>Choksey, CICO</td>
</tr>
</tbody>
</table>
B. **SANITARY AND WATER SUPPLY WORK (INTERNAL)**

**FIRST QUALITY TO BE USED**

1. **Cast Iron Pipes and Fittings**

2. **RCC Pipes**
   - Indian Hume Pipe Company, Delhi / Allahabad / Chandigarh / Lucknow; Hindustan Pressure Pipes, Kolhapur; Dhere Concrete Products, Pune or any other approved manufacturer conforming B.I.S. Standard

3. **GI Pipe**
   - Indian Tube Company, Calcutta; Kalinga Tubes Limited, Cuttack; Gujarat Steel Tube; Zenith Tube Co. Kolaba; Bharat Steel Tube, New Delhi; Jindal; Shivmoni Steel Tubes Limited, Bangalore; Sekhar Iron Works, Calcutta; Jain Tubes, Ghaziabad; Khandelwal Tubes, Nagpur.

4. **G.I. Fittings**
   - International Pipe Works, Calcutta; R.M. Engineering Works, Jalandhar; Bombay Metal Company, Bombay; Tarapada Das & Sons, Howrah; Annapurna Metal Works, Calcutta.

5. **Gun Metal Valves and Copper Alloy Valve**
   - Leader Engineering Works, Jalandhar; Neta Engineering Works, Jalandhar; Lakshmi Metel Works, Jalandhar; Bombay Metal & Alloys, Bombay; Luster Sanitary Fittings, Jalandhar; Annapurna Metal Works, Calcutta.

6. **Sluice Valves, Check Valves etc.**

7. **Brass Fittings**
   - Leader Engineering Works, Jalandhar; L & K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial Corporation, Bombay.

8. **C.P. Fittings**
   - Ego Metal Works, Ballabhgarh; Jaquar Industries, Delhi; Sona Plumbing Fixtures Limited, Calcutta; Gem Sanitary Appliances Pvt. Ltd., Delhi; Essco Sanitations, Delhi; Bilmet, Bombay.

9. **W.C. Pan, Wash Basin, Urinals, Sink Low down Flushing Cistern**
   - E.I.D. Parrys, Madras, Hindustan Sanitaryware, Calcutta; Neivilsi Ceramics, Tamil Nadu; Cera Ceramics.

10. **E.W.C. Seats**
    - Nuchem Plastics Limited, Faridabad; Commander, Bombay; Bestollite Jasco Sales, Bombay; Agarwala Products, Bombay.

11. **Flushing Cistern**
    - Arail Brothers, Delhi; Allied Industries, Jaipur;

12. Hydrants

Brady's, Bombay; Firex, Bombay; Upadhyaya Valves, Calcutta; Eddy Foundry, Calcutta, Minimax.

13. Mirrors

Atul Glass Works, Vallabh Glass Works, Goldenfish

14. White Glazed Tiles

H & R Johnson Tiles Company, Bombay; Somani Pilkingtons Co., Haryana

15. Asbestos Cement Pipes and Fittings


16. Stone Ware (Salt-Glazed) Pipes

Hind Ceramics Limited, Orissa; Ceramic Industries Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati Moulds Limited, Nagpur; Kiran Potteries, Hyderabad; Perfect Sanitary Pipes, Bharatpur.

23.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.
SPECIFICATION FOR CIVIL WORKS

PART – II WORKMANSHIP
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<td>Excess Excavation</td>
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<td>Disposal of Excavated materials</td>
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<td>2.14</td>
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</table>

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1.0 GENERAL

1.1 Standard

A high standard of workmanship in all trades will be required. The Contractor shall ensure that only skilled and experienced workmen are employed.

1.2 Supervision

The Contractor's supervising staff shall be fully qualified and experienced in the types of work being carried out under their supervision and shall be capable of ensuring that work is executed efficiently and as per specification.

1.3 Temporary works

Where required, the Contractor shall furnish such details of his temporary works as may be called for by the Engineer and the Contractor shall satisfy the Engineer as to their safety and efficiency. The Engineer may direct that temporary works, which he considers unsafe or insufficient, shall be removed and replaced in a satisfactory manner.

1.4 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

In case of any conflict in meaning between these specifications and those of BIS or IRC, or British/International Standards, the provisions of these specifications shall prevail.

1.5 Base lines and bench marks

The Contractor shall establish and maintain, to the satisfaction of Engineer, the base lines and bench marks, based on which the works are set out. Where such base lines and bench marks are provided by the Engineer, the Contractor shall maintain these throughout the period of construction without causing any disturbance to them.

1.6 Setting out

The Contractor shall set out all the works to be executed by him, in line with the standard base lines, levels, position and bench marks and truly as per drawings within the accepted tolerance limits at no extra cost to Owner. The Contractor shall be solely responsible for the setting out of all the works, to be executed by him and the approval of such setting out by the Engineer shall in no way absolve the Contractor his responsibility for carrying the work to the true lines, levels and positions as per drawings.

1.7 Dewatering

The Contractor shall carry out all the works, in dry and workable condition and maintain the same in dry condition till the final handing over of works at no extra cost to the Owner. For this the Contractor shall make all the necessary provisions of dewatering, wherever necessary, to the entire satisfaction of the Engineer.

1.8 Safety of existing work
Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work at no extra cost to the owner.

1.9 Protection of existing services

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or over ground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material at no extra cost to the owner.

1.10 Handing over of work site

On completion of work, the Contractor shall remove all rubbish, debris, surplus materials, temporary work etc., from the site. The site shall be handed over in a tidy and workmanlike manner at no extra cost to the owner.

2.0 EARTH WORK

2.1 Scope

This chapter deals with earth work and excavation for civil works in site, formation/oversite leveling, foundations, cutting and grading for roads/pavement and railways, canals, embankments other than water retaining embankments trenching for drainage and other buried services and the like.

2.2 General

The Contractor shall carry out the excavation strictly to the lines and levels, in conformity with the drawings or instructions of the Engineer.

2.3 Setting out

Before commencement of earthwork block levels of existing ground shall be taken by the Contractor jointly with the Engineer, plotted and signed in token of acceptance of ground levels. Excavation shall not be commenced until the initial ground levels have been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails, marking boundaries or centre lines, as the case may be, and the same maintained for reference and future checking. Chainaie stones at regular intervals shall be set up for embankments. All setting out operations shall be got checked and approved by Engineer. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing, and in case any error is noticed at any stage in the contractor’s work, it shall be corrected/rectified by him without any cost to the Owner.

2.4 Site clearance and demolition

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material, if any, shall be the property of the owner and shall be stacked properly as directed by the Engineer. The areas to be covered with embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old
concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. Payment for cutting and removal of trees, stumps, dismantling existing structures and stripping shall be regulated by the description in the Schedule of Items or Part V of these specifications.

2.5 Classification of soil

The Engineer will decide the class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor:

A) Ordinary Soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

B) Hard Soil

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.

C) Soft /Decomposed Rock

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc. This include lime stone, sand stone, weathered rocks and hard conglomerates etc and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation. The fact that contractor resorts to blasting for his own reasons shall not mean that the rock is hard and classified as hard rock.

D) Hard Rock

This comprises of rocks which require blasting for excavation. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any other agreed methods.

2.6 Method of excavation

The Contractor may carry out excavations, filling and compaction by any method considered most suitable, and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come, during the construction. No foundation work shall be taken up until the surfaces are properly drained.

2.7 Excavation of soils other than hard rock

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimen-
Excavation shall be carried out in any material encountered including road surfaces, pavements, buried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 metres of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations.

In firm soil the sides of the trenches shall be kept vertical upto a depth of 2.0m from the bottom and for a greater depth, trench shall be widened by allowing steps of 50cm on either side after every 2.0m depth from the bottom, so as to give a vertical side slope of 1/4 : 1. Where the soil is soft, loose or slushy, the width of the steps shall be suitably increased or sides suitably sloped or suitable shoring and strutting provided as directed by the Engineer. For trenches deeper than 2.0m, the Contractor shall obtain detailed instruction from the Engineer in writing regarding the stepping, sloping of sides or shoring and strutting to be done. For these bye-works, no extra cost will be paid to the Contractor.

2.8 Excavation in hard rock

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary licence for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc., shall be such that they will neither open seams nor damage or shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-5 grade or (1:5:10) cement concrete in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required, is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods.
All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

2.9 Cutting and filling for site leveling

Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimised. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and deslushed before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials encountered to enable laying of service lines or drainage channels or any other desired purpose. Excavation shall be done to lines and levels shown in drawings and shall be done providing adequate measures for stability. Vertical wooden sleepers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Centre lines shall be marked on horizontal sleepers or rails, laid across the trenches. Depths of excavation and pipe invert levels shall be checked by means of boning rods of appropriate lengths. Trench beds shall be trimmed and rammed with sprinkling of sand or moorum to required gradients for continuously supporting the pipelines. Trenches shall be locally deepened and widened to receive sockets and permit joints to be inspected.

Timbering

In case of trenches, tunnels, channels, drains, manholes, chambers, basement and other places where the soil is not capable of being retained without the support, timbering as directed by the Engineer shall be resorted to. It shall be the responsibility of the Contractor to take all the necessary steps to prevent the sides from collapsing.

2.11 Excavations for foundations

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be transported, spread and levelled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorised by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc., These shall be removed only when work in the pit is completed, with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-5 grade, or (1:5:10) cement concrete if so ordered by the Engineer at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-5 grade/(1:5:10) cement concrete or sand as directed. If the bottom of excavation has been left exposed not through neglect or fault of the Contractor and it has
become deleteriously affected by atmospheric action and water, such portion of
deteriorated foundation material shall be removed and made good by lean concrete of
grade M-5/(1:5:10) cement concrete or sand as directed and such extras will be paid for.

2.11.1 For deep excavation in the proximity of existing buildings, foundations, streets, railway
tracks, underground cabling, gas piping, water and drainage lines, and the like, adequate
appropriate precautions shall be taken to protect such structures or works from damage,
displacement or settlement, either as an immediate result of the excavation or as after
effect, discernible with the passage of time. The method of protection of existing
structures and services may include sheet piling, shoring, strutting slinging or any other
method including dewatering. Payment for such protective work shall be governed by the
description given in the Schedule of Items for the particular work.

2.11.2 For excavation adjoining existing piles care shall be taken to ensure that no pile under
any circumstances is exposed from the top for a height exceeding 2 metres. No strutting
shall be done against exposed piles, nor exposed piles ever used for tying guy ropes or
supports either temporarily or permanently.

2.12 Excess excavation

All excavation done beyond the specified limits or directions of Engineer shall be
considered as excess excavation. They shall be made good as prescribed below by the
Contractor at his cost:

i) Excess excavation in case of site leveling shall be made good by filling and
   compacting with material same as the surrounding material. Degree of
   compaction shall be at least the same as the surrounding material.

ii) Excess excavation in case of trenches shall be made good by filling and
    compacting with selected earth to the same compaction as the surrounding
    material or as directed by Engineer. This shall be done in layers not exceeding
    150 mm thick, moistened and thoroughly compacted by tamping.

iii) Excess excavation in case of foundation beyond required depths shall be made
    good by filling with lean concrete of M-5 grade/(1:5:10) cement concrete.

2.13 Disposal of excavated materials

Excavated materials that are unsuitable for use in construction works or in excess of
construction requirements shall be disposed off in dumping yards or in locations indicated
by Engineer. Waste piles/heaps shall be located in such places where they will not
interfere with natural flow of rain water access or transport or with the access to nearby
structures. When required, they shall be levelled and trimmed to such lines and levels as
indicated by Engineer.

2.14 Back filling of trenches

Trenches shall be backfilled after pipes or service lines are tested and approved. Filling
shall be done with earth in 150 mm thick layers free from unwanted material and well
rammed. Soft material shall be used in bottom of trenches upto a level of 150 mm above
the top of pipes before backfilling with other fill materials. All clods and lumps shall be
broken before placement. Care shall be taken not to disturb, break or damage the pipes
during backfilling and compaction process.
2.15 Backfilling of foundations

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats, wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations, all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Hydro-insulation, Bitumen painting or application of anti-corrosive protective and anti-termite treatments shall have been completed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layer shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to lines and levels indicated in the drawings and/or as directed by the Engineer. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.16 Filling under floors

Crusher dust to be used for filling under floors shall be soil free from harmful minerals, vegetable matter etc., and shall not be expansive soils. Filling shall be done in well compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted. The entire area to be covered by flooring shall be finally dressed and trimmed to required levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.17 Load bearing fills

Load bearing fills include embankments for roads and railways and such other earth fills above ground levels provided for protection of fuel oil tanks, pads for storage tanks, drain, bunds and the like. Fill materials shall either be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soils selected for filling in embankments shall be of uniform quality and free from boulders, organic materials and other objectionable matter. Soils having high silt and clay content and having laboratory maximum dry density less than 1.44 gms per c.c. shall not be used for load bearing fills. For fills greater than 3 m in height soils shall have laboratory density not less than 1.52 gms per c.c. Soils for top 500 mm of fills for roads and railways shall have laboratory density not less than 1.65 gms per c.c. and shall not have marked swelling and shrinkage properties.

Foundation preparation for embankments shall be done as prescribed under site clearance. The founding strata shall be compacted as much as possible by rolling or tamping before placement of fill material. The water content of founding strata should be the same as that specified for embankment fill. Any pockets of loose material or depressions left in founding strata as a result of clearing operation shall be filled and compacted with the same material as the surrounding founding strata. When an embankment is to be placed on steep sloping ground the surface of the ground shall be trenched in steps or trenched or broken up in such a manner that the new materials bonds well with the founding strata.

Fill material shall not be placed until foundation has been inspected and approved by Engineer. Material shall be placed in even, continuous, horizontal layers over full width of embankment in well compacted layers not exceeding 200 mm thickness. Each layer shall be compacted by means of smooth rubber tyred rollers, sheep-foot rollers, tractors, tampers or other mechanical means as may be found suitable for the location. Before rolling, the water content shall be checked and corrected by sprinkling with water or adding dry material or aeration as may be required. This shall be followed by mixing and
the layer left for soaking before compaction. The water content shall be within plus or minus 2% of Standard Proctor Optimum. Density of compacted layers shall be determined by sand replacement method. Average compacted density shall be at least 95% of Standard Proctor Density. The number of tests to be conducted for determination of moisture content and density shall be as prescribed by the Engineer. Side slopes of embankments shall be formed along with the main embankment. No side dumping shall be done for the formation of slopes. When required the width of each layer shall be constructed slightly in excess of required width and slopes trimmed to remove loose edge materials and completed to lines shown in drawings or as directed by the Engineer. Subgrades for road works shall be thoroughly wetted sufficiently in advance of placing of any base course and it shall be ensured that it is firm and moist for at least 50 mm below the surface. Should the subgrade for any reason be loose or have density less than required, it shall be recompacted and refinished. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or scaling. No traffic or hauling equipment shall be permitted to ply on finished subgrade and any damage caused to such portion shall be made good by the Contractor at his own cost.

2.18 Turfing

The slopes of embankment shall be dressed to line and slightly roughened to bond and hold a surface dressing consisting of 150 mm humus layer of soil. The entire surface shall then be covered with turf consisting of blocks or strips of grass of approved species. The sod shall include a net of roots and earth at least 75 mm thick. The sod shall be laid on slope in close contact and then tamped in place so as to close and fill the joints between blocks.

Immediately after placing the turf, slope shall be thoroughly wetted and kept wet for a sufficient period to assure plant growth. Watering shall be continued until the grass takes root firmly and the whole area presents a uniform appearance. In the event that the plant growth has not taken place within the period of maintenance such areas or patches shall be redone by the Contractor at his own cost.

3.0 ANTI-TERMITE TREATMENT

3.1 Scope

The scope of work includes setting up a chemical barrier against attack by subterranean termites while the building is under construction.

3.2 Execution

3.2.1 General

Unless otherwise specified all work shall in general be executed as specified in IS : 6313 Part-II -1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.2.2 Chemicals and rate of application

Chemical like chlorpyriphos 20% EC (Conforming to IS 8963 - 1978) in 1% emulsion shall be applied by pressure pumps, uniformly over the area treated. (1 part chemicals + 20 parts water = 1% emulsion).
3.2.2.1 Treatment of pits, trenches & basement excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300mm) for column pits, walls, trenches and basements shall be treated with emulsion @ 5 liters per sq.m. of surface area. Backfills around columns, walls, etc., shall be treated @ 7.5 liters per sq.m. of the vertical surface. Treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centers closed to the wall surface and spraying the emulsion in the specified dose.

3.2.2.2 Treatment of top surface of plinth filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crow-bars on the surface of compacted plinth fill. Emulsion at the rate of 5 litres per sq.m of surface shall be applied prior to laying soling or subgrade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

3.2.2.3 Treatment of doors, windows & soil surrounding pipes, Wastes and conduits.

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. All the wooden door/window frames on the ground floor of the buildings shall be treated with the insecticidal solution.

3.2.2.4 Treatment of expansion joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

3.3 Acceptance Criteria

The Contractor shall give a 10 year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the Owner.

4.0 CONCRETE PLAIN & REINFORCED

4.1 Scope

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives:

(a) The provision, at all locations on the site, of dense workable concrete, having the specified characteristic strength.

(b) The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the internal and external dimensions of structures as per drawings and maintaining the size, shape number and locations of reinforcements, inserts etc., as specified in the drawings providing the surface finish after stripping off the formwork to ensure the structural configurations as per drawings as well within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.
4.1.1 The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456-1978 "Code of Practice for Plain and Reinforced Concrete".

4.2 Materials

For materials, reference to Part - I (Materials) shall be made.

4.3 Grades of Concrete

The grades of concrete unless otherwise specified 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 schedule of items:

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm²)</th>
<th>Nominal Maximum Aggregate Size (mm)</th>
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</thead>
<tbody>
<tr>
<td>M-5A</td>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td>M-5B</td>
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<td>40</td>
</tr>
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<td>M-7.5B</td>
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</tr>
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<td>M-10C</td>
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<td>M-30D</td>
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</table>
### General Technical Specification

**Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm²)**

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<tr>
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<tr>
<td>M-40D</td>
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</tbody>
</table>

**Notes:**
A,B,C,D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 63mm, 40mm, 20mm & 12mm respectively.

Unless otherwise specified in the drawings or schedule of items 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 & massive reinforced foundations | 40 mm & 63 mm |

#### 4.4 Mix Design

**4.4.1 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 Engineer to such proportions before he starts 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 authorisation 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.

**4.4.2 For the all major and important R.C. 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 I.S. 10262-1982 or any other approved standard methods.**

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

**4.4.4 The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, cement content of concrete shall not be reduced below the quantities specified as under except for the cases specifically approved by the Engineer.**
### General Technical Specification

<table>
<thead>
<tr>
<th>Grade of concrete</th>
<th>Minimum cement content per Cu.m finished concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-15</td>
<td>290 kg</td>
</tr>
<tr>
<td>M-20</td>
<td>320 kg</td>
</tr>
<tr>
<td>M-25</td>
<td>380 kg</td>
</tr>
<tr>
<td>M-30</td>
<td>410 kg</td>
</tr>
<tr>
<td>M-35</td>
<td>490 kg</td>
</tr>
<tr>
<td>M-40</td>
<td>550 kg</td>
</tr>
</tbody>
</table>

**4.5 Water/Cement Ratio**

4.5.1 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 the characteristic strength of concrete with stipulated water/cement ratio.

4.5.2 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, prestressed structure, thin precast members etc. the water cement ratio shall be kept low and preferably not exceeding 0.45.

4.5.3 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.

**4.6 Workability**

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

4.6.2 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 finalisation 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 of workability. The workability tests shall be carried out in accordance with IS:1199-1959.

4.6.3 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 consistent with added water.

4.6.4 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 use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer’s specification and with the approval of the Engineer.

4.6.5 The usual limits of consistency for various types of structures are given below:

#### Limits of consistency
<table>
<thead>
<tr>
<th>Degree of Workability</th>
<th>Slump in mm with Standard - Cone</th>
<th>Use for which concrete is suitable as per IS : 1199</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>0.0 25.0</td>
<td>Large mass concrete structure with heavy compaction equipment, roads and the like.</td>
</tr>
<tr>
<td>Low</td>
<td>25.0 50.0</td>
<td>Uncongested wide and shallow R.C.C structures</td>
</tr>
<tr>
<td>Medium</td>
<td>25.0 75.0</td>
<td>Deep but wide R.C.C structures with congestion of reinforcement and inserts</td>
</tr>
<tr>
<td>High</td>
<td>75.0 125.0</td>
<td>Very narrow and deep R.C.C structures with congestion due to reinforcement and inserts</td>
</tr>
</tbody>
</table>

**Note:**
Not withstanding any thing mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer. With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

### 4.7 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: 456-1978 shall be taken as guideline for durability considerations.

### 4.8 Trial Mixes

4.8.1 After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.

4.8.2 Before starting the trial mixes, necessary preparatory works like sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents in the aggregates, shall be completed according to the I.S. Codes 383-1970 and 2386-1963.

4.8.3 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.

4.8.4 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.

4.8.5 Six numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. 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 control at
site. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.

4.8.6 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 therefrom the design of the Approved Mix for that particular grade of concrete.

4.8.7 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.

4.9 Nominal Mix Concrete

4.9.1 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 & M-20, nominal mix concrete may be used with the permission of Engineer, Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20.

4.9.2 The proportioning of materials for nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I.S. 456-1978. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456-1978 shall also be taken into consideration.

4.10 Volumetric Mix Concrete

Where concrete is specified in volumetric proportions such as 1:4:8, 1:3:6, 1:2:4, 1:1 1/2:3, 1:1:2 etc., in the schedule of items, coarse and fine aggregates shall be measured by volume and cement by weight. The water cement ratio shall be within 0.45 to 0.70 depending upon the workability.

4.11 Batching of Concrete

4.11.1 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, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly.

4.11.2 Aggregates

4.11.3 For both Design Mix concrete and Nominal Mix concrete, the aggregates (coarse and fine) shall be batched by weight.

4.11.4 In particular cases, or where weigh-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates throughout the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on 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 made for bulking in accordance with I.S. 2386 (Part-III)-1963.

4.11.5 Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.
4.12 Water

4.12.1 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 fitted to the mixer.

4.12.2 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 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 as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

4.12.3 Determination of moisture content in the aggregates

Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III)-1963. 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>
<th>% by weight</th>
<th>Lit / m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very wet sand</td>
<td></td>
<td>7.5</td>
<td>120</td>
</tr>
<tr>
<td>Moderately wet sand</td>
<td></td>
<td>5.0</td>
<td>80</td>
</tr>
<tr>
<td>Moist sand</td>
<td></td>
<td>2.5</td>
<td>40</td>
</tr>
<tr>
<td>Moist gravel &amp; stone chips**</td>
<td></td>
<td>1.25 - 2.5</td>
<td>20-40</td>
</tr>
</tbody>
</table>

** - Coarser the aggregate, less the water it will carry.

4.12.4 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.

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

- Cement within plus or minus 2% by weight.
- Aggregate within plus or minus 5% by weight.
- Water within plus or minus 0.5% by weight.

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 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 colour and consistency. The mixing time from the time of adding water shall be in accordance with IS: 1791-1985 but in no case less than 2 minutes or at least 40 revolutions.
4.13.1.2 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 to the Owner.

4.13.2 Transportation of concrete

4.13.2.1 Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by such 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.

4.13.2.2 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.

4.13.3 Actions before placement of concrete

4.13.3.1 Programme of works

At the beginning of every fortnight, the contractor shall give his detailed concreting programme for that fortnight to the Engineer. Such programmes, shall specify all information such as the locations where concrete is to be poured, type/grade of concrete, volume of concrete to be poured, number and Type of vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc.

4.13.3.2 Checking & approval

Before placement of concrete, the contractor shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer. To facilitate such checking, the contractor shall complete all his works according to the drawings and specifications well in advance before placement of concrete at least 36 hours for all major/important/complicated works and 24 hours for all minor/ordinary/simple works. The checks are purely in the interest of the work and to draw the contractor's attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the contractor from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

4.14 Preparatory Works/Surface Preparation

4.14.1 For concrete directly on earth foundation

4.14.1.1 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 any extra cost to the Owner. 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.

4.14.1.2 The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the
final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any extra cost to the Owner.

4.14.2 For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and water-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted. For vertical construction joints a neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of freshly mixed mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix and applied immediately before placing of the concrete. On this surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.

4.14.3 (a) 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.

b) Over walls

Building paper over average 12mm thick cement sand bearing plaster of 1:4 mix with neat cement finish shall be provided at the bearings of slabs over walls as directed by the Engineer.

4.14.4 Inside the formwork (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 all sort of dirt, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirt, grease/oil, rust, foreign/deleterious materials etc. Before placement of concrete, the form works coming in contact with concrete, shall be coated with form oil or raw linseed oil 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 do not come in contact with the reinforcement.

4.15 Placing and Compaction of Concrete

4.15.1 The concrete shall be placed and compacted before setting commences & 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 over 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 embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.
4.15.2 Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

4.15.3 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.

4.15.4 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.

4.15.5 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer.

4.15.6 The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

4.15.7 For members involving vertical placing of concrete (e.g. columns, walls etc.), each lift shall be deposited in horizontal layer extending 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.

4.15.8 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.

4.15.9 Utmost care shall be taken to avoid the displacement of reinforcements/embedded parts or movement of formwork or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.

4.15.10 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.

4.15.11 Should any unforeseen occurrence results 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 at his own cost.

4.15.12 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 embedments, holes, openings etc., well within the accepted tolerance limit.

4.16 Construction Joint & Cold Joints
4.16.1 Construction joints

4.16.1.1 Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings.

4.16.1.2 Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guidelines:

(a) In Columns

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

   (ii) In framing of 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 top surface of the beam/slab or at the top surface of beam/Slab whichever facilitates formwork.

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

(b) In walls (horizontal construction joints)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Walls projecting from base slab</td>
<td>300 mm from top of base slab</td>
</tr>
<tr>
<td>(ii)</td>
<td>Walls supporting the suspended slab</td>
<td>75 mm from the lowest soffit of the slab</td>
</tr>
</tbody>
</table>

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 water-tight.

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint for 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 no construction joints.

   (ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the 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, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.

(f) In slabs resting on ground
(i) **For Plain concrete**

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

(ii) **For nominally reinforced slab**

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

(i) **For the basement slabs which act as structural member**

There shall be no construction joint.

(g) **In ribbed beam**

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

4.16.1.3 In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

4.16.1.4 The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures/embedments. All construction joints shall be made to form a tongue and groove joint.

4.16.2 **Cold joint**

An advancing face of a concrete 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:

(a) 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.

(b) 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 the cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep in to the layer of concrete.

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded 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.

4.17 **Requirements for Concreting in Special Cases**
4.17.1 Concreting in deep lifts

Placing of concrete in lifts exceeding 2 M in columns and walls is in the category of deep lifts.

4.17.1.1 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.

4.17.1.2 The placement of concrete shall preferably be by tremie, chute or any other approved method.

4.17.1.3 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.

4.17.2 Concreting under water

When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with Clause 13.2 of IS: 456-1978.

4.17.3 Cold weather concreting

When conditions are such that the ambient temperature may be expected to be 4.5 C degree or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II)-1981.

4.17.4 Hot weather concreting

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I)-1975 and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree ‘C’.

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.

4.18 Finishes to Exposed Surfaces of Concrete

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

4.18.1 Surface which do not require plastering

Surface in contact with casings 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 centerings, 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 exceeds 5 mm and the plastering shall be in cement and sand mortar.(1:3).

4.18.2 Exposed surfaces which need plastering
Surfaces of beams/columns flushing with the block work or other structures where intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.3 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 and finished rough.

4.18.4 For monolithic finish

Where no more finishing course is to be applied 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 sloped with 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. Troweling shall be such that the surface is flat, smooth and neatly finished.

4.19 Curing of Concrete

4.19.1 General

The purpose of curing is to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the contractor.

4.19.2 Different methods of curing

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

(a) Curing by direct water.

(b) Curing by covering the concrete with absorbent material and kept damp.

4.19.3 Curing by direct water

This is done either by ponding or spraying water.

(a) Ponding

Ponding is widely used for curing slab and pavements. Earth bunds 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.

(b) 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. Alternate wetting and over drying shall be avoided.

Curing by spraying water shall be continued at least for 18 days after final setting.

4.19.4 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 setting.

4.20 Testing of Concrete

4.20.1 General

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

4.20.2 Consistency test (tests of fresh concrete)

4.20.2.1 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 I.S. 1199-1959 as directed by the Engineer.

4.20.2.2 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 the Owner and shall be kept by the Contractor at site in safe custody.

4.20.2.3 The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 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.

4.20.2.4 For any particular batch of concrete, if the results do not conform to the requirements as specified in 4.20.2.3 or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the Owner.

4.20.3 Strength test of concrete

4.20.3.1 While placing concrete, the Contractor shall make 6 nos. of 15 cm 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: 456-1978 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516-1959. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

4.20.3.3 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 Owner.

(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 of casting
(f) Crushing strength at 7 days
(g) Crushing strength at 28 days
(h) Any other information directed by the Engineer.

4.20.4 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: 456-1978.

4.20.5 Non-destructive tests on hardened concrete

4.20.5.1 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: 456-1978, non-destructive tests on hardened concrete like core test 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.

4.20.5.2 The core tests and load tests shall comply with the requirements of clause 16.3 and 16.5 of IS: 456-1978 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456-1978 shall be applicable.

4.20.6 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) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at Contractor's expense.

2) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense and the resultant structures affected due to such rejection shall be made good at contractor's expense.

3) Modification/remedial measures if approved by the engineer to be carried out at contractor's expense.

4) Accept the work with reduction in the rate in appropriate item subject to the provisions of clause 15 of IS 456-1978 provided it is technically acceptable. The reduction in the rate shall be as given below :-

   i) When test strength of the sample is above 90% of the characteristic strength, payment shall be made 10% less than the contract rate.

   ii) When test strength of the sample is between 80-90% of the characteristic strength, payment shall be made 25% below than the contract rate.
4.20.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS: 456-1978 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner 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.

4.21 Steel Reinforcement

4.21.1 Material

Material shall be as specified in the respective schedule of Items. The specifications of materials shall be as per Part-I.

4.21.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost of the owner.

4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502-1963 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456-1978 "Code of Practice for Plain and Reinforced Concrete".

4.21.4 Welding of Reinforcement

Welding of mild steel reinforcement bars conforming to IS:432 (Part-I)-1982 shall be done in accordance with IS: 2751-1979 "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be at least 3 mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more.

Welding of cold worked high strength deformed bars conforming to IS: 1786-1985 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld-I or Ferro Weld-II or equivalent). Oxy-acetylene welding shall not be used.

Butt welding of bars upto 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars upto 32 mm diameter for horizontal splices shall be done either by single Vee-groove weld or double Vee-groove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxy-acetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The
throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0.65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is at least 1.62 times the area of bar being spliced. More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located at least at a distance of 50 times the diameter of bar from bends.

Tests

Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751-1979. The number of tests will be as laid down in IS: 2751-1979 or such larger number as the Engineer may decide having regard to the circumstances.

4.21.5 Cleaning

All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.

4.21.7 Clear cover

Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456-1978.

4.21.8 Light structural work and embedded metallic parts, conduits

4.21.8.1 Fabrication of metallic parts & light structural works

Fabrication of all structural steel work shall be done in accordance with IS: 800 -1984 "Code of Practice for use of Structural Steel in General Building Construction". Workmanship shall match to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly inter-changeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimise site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened of flattened
by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 -1969 "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814-1991 "Specification for covered electrodes for metal arc welding of mild steel shall be used.

### 4.21.8.2 Transportation and Storages

All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

### 4.21.8.3 Erection of light structural work

Erection of light structural work shall be carried out in accordance with the provisions of IS: 800-1984. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

### 4.21.8.4.1 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications.

Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged with suitable stoppers to prevent the ingress of water, grout, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, Unshapely profiles or other similar inserts are required to be placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary.

All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

### 4.21.8.4.2 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer free of cost to the Owner.

Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50mm beyond each side of the weld line shall be cleaned off.

### 4.22 Shuttering

#### 4.22.1 General
All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a live load of 400 Kg/m² in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of his responsibilities.

4.22.2 Material

The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant and shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or seasoned timber board. Where ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood which can be shaped correctly.

4.22.3 Fixing

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection or movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The form work shall be so designed that the sides are independent of the soffits and the side forms can be removed easily without any damage or shock to the concrete.

4.22.4 Wrought shuttering

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface.

The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3 mm.

4.22.5 Rough shuttering

Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

4.22.6 Special provision
4.22.6.1 Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.

4.22.6.2 In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used.

4.22.6.3 Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct.

4.22.6.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar if so directed by the engineer.

4.22.7 Preparation for concreting

Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

4.22.8 Removing

4.22.8.1 Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction.

4.22.8.2 Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

4.22.8.3 Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :-

<table>
<thead>
<tr>
<th>i)</th>
<th>Walls, columns &amp; vertical faces</th>
<th>24 to 48 hours as may be directed by the Engineer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii)</td>
<td>Bottom of slab upto 4.5 m span</td>
<td>7 days</td>
</tr>
<tr>
<td>iii)</td>
<td>Bottom of slab above 4.5 m span, bottom of beam and arch, rise upto 6 m span</td>
<td>14 days</td>
</tr>
<tr>
<td>iv)</td>
<td>Bottom of beam and arch rise over 6 m span</td>
<td>21 days</td>
</tr>
</tbody>
</table>

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc.,

4.22.8.4 Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.
4.22.9 Contractor's responsibility

Any damage resulting from faulty preparation, premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

4.22.10 Irrecoverable shuttering

In cases where the shuttering cannot be removed without damaging the structure itself or where removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such shuttering shall be classified as irrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.

4.22.11 Metal Forms

Where permanently left-in-place metal forms or deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the requirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer, whose performance guarantee shall be obtained and submitted to the Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.

4.23 Damp Proof Course Concrete

4.23.1 Thickness

It shall be as specified in the drawings or in the items.

4.23.2 Mix

The grade of mix shall be as specified in the drawing or schedule of quantities. If nothing is specified, the mix shall be 1 part of cement : 1 1/2 part of coarse sand : 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer's specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5.

4.23.3 Preparation of base surface

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

4.23.4 Placing and compaction

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as specified for the concrete in beams. The concrete shall be well compacted to make it dense.

4.23.5 Finishing

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.

4.23.6 Curing
The D.P. course shall be kept continuously moist at least 10 days.

4.24 Grout

4.24.1 Scope

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

4.24.2 Grouting under base plates

Grouting under base plates of equipments/structures shall be of cement mortar 1:2 for thickness upto 25 mm. For thickness exceeding 25 mm, concrete of grade specified in the drawing or minimum M-20 grade using 10 mm down graded aggregates shall be used. The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete, where so specified.

The grout shall either be "dry" concrete or mortar or "wet expanding" concrete or mortar as the Engineer may direct. A dry grout shall have a slump not exceeding 6 mm. It shall be rammed under the horizontal surface with the aid of suitable tools. A "wet expanding" grout shall have a slump of at least 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and in accordance to the Manufacturer's instructions.

4.24.3 Grouting the pockets/holes in concrete

Depending upon the size of the pockets/holes in the concrete, the mix of the grout shall be either of concrete or of cement sand mortars. Normally the grade of such concrete/mortar shall be M-20 unless specified otherwise. In filling the holes of foundation bolts and expanding admixture of approved type shall be used as per manufacturer's specification.

4.24.4 Workmanship

4.24.4.1 The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary, chipping shall be carried out on such surface to make it completely rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position. Before grouting the surface shall be thoroughly cleaned with compressed air/water jet.

4.24.4.2 Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

4.24.4.3 Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

4.24.4.4 The grout shall be placed within 30 minutes of being mixed. The grout shall be poured and then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly. Where the gap is very small or unapproachable for the placement of concrete, the Contractor shall grout by pressure grouting and in that case the mix may be of cement sand mortar of the appropriate grade but in any case the water
cement ratio shall be as low as possible. Neither "Dry" grout (having slump 6mm or less) nor expanding wet grout shall be grouted with any type of vibrating machine.

4.24.5 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist at least for 10 days.

4.25 Concreting in Water Retaining Structures

General requirements

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified herein before in this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II)-1965 to make dense and impervious concrete. As specified herein before all the construction joints shall be provided with approved water bars. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as directed by the Engineer.

4.26 Application of Live Load

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out on the last concrete poured in structure.

4.27 Foam Concrete

This shall be of average 50mm thickness or as specified or as shown on the drawings. This may be laid in in-situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m2h/degree C. The weight of the insulating material shall be from 0.5 to 0.75 gm/cm3, strength not less than 5 Kg/sq.cm or (0.5N/sq.mm.). In general, the main ingredients of Foam Concretes are cement, fly ash and foaming agent and the work shall be carried on by specialised Agencies/Companies. Before starting the laying of foam concrete sample shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to take the usual work loads and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, sample batches of mix shall be kept for test if so desired by the Engineer.

5.0 MASONRY

5.1 General

This specification deals with masonry and allied works in foundation, plinth and superstructure.

5.2 Materials

For specifications of materials Part-I shall be referred.
5.3 Selection of Mortars

Mortar for masonry shall conform generally to IS: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Cement Mortar

5.4.1 Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic metre. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

5.4.2 The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work.

If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

5.4.3 Fresh mixed mortar, in case becoming stiff due to evaporation of water may be retempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only upto a maximum of 2 hours from the time of addition of cement in the mortar.

5.5 Brick Work

5.5.1 Storage and handling bricks

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. The supply of bricks shall be so arranged that as far as possible at least two days' requirement of bricks is available at site at any time. Bricks selected for different situations of work shall be stacked separately.

5.5.2 Soaking & Cleaning bricks

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

5.5.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212-1991 and got checked by the Engineer.

5.5.4 Laying of bricks
5.5.4.1 Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shapes as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.5.4.2 Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

5.5.4.3 Walls coming in contact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of M.S. inserts or lugs used shall be measured and paid separately under relevant items). Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

5.5.4.4 Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to complete bond or as closers or around irregular openings.

5.5.4.5 Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging their edges.

5.5.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.5.4.7 Making of grooves, sleeves and chases shall be done, during the construction, to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.

5.5.4.8 Fixtures, plugs, frames, pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.5.4.9 Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

5.5.4.10 All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of one metre and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall. Tooothing shall not be allowed in brick work, for raking back. The top layer just below the R.C.C slab or beam shall be laid with frogs down over a layer of mortar on full width.
5.5.4.11 Openings in brick work

Openings shall be made in brick work, which may be of any shape, size, at all levels, heights or depths, including round openings, as shown in the drawing or as directed by the Engineer, maintaining the necessary bond using a minimum of cut bricks. Openings in external face walls, the sills, jambs, soffits of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.5.4.12 All exposed brick work shall be rubbed down, thoroughly washed, cleaned and pointed as specified. Where face bricks of specific quality are used the same shall be rubbed with carborundum stone.

5.5.5 Half-brick masonry

5.5.5.1 Half-brick work shall be done in the same manner as for brick work except that all courses shall be laid in stretchers. Both faces shall be true to plane and the joints raked on both faces.

Where reinforcement is considered necessary or specified and shown in drawing, M.S. bars or hoop iron shall be provided as stipulated in the Schedule of Items or as directed by the engineer. The reinforcement shall be cleaned of rust and loose scale with a wire brush, and shall be laid straight on the mortar and lapped with the dowel bars provided in the column, securely anchoring them at their ends where the half-brick wall butts. The batching of mortar usually shall be in the proportion of 1:4 or as stipulated in the Schedule of Items. Half of the mortar for the joints shall first be laid and the other half laid after the reinforcement is laid in position, so that the reinforcement is fully embedded in position.

5.5.6 Brick on edge masonry

The work brick on edge masonry wall in superstructure shall be done in the same manner as mentioned for brick work except that it shall always be reinforced with wire mesh netting of approved variety as specified in the item and embedded in cement mortar at interval as specified in the Schedule of Items. The wire netting shall be continuously laid and securely anchored with the dowel bars provided & projecting from the walls/RCC structure or steel structures at their ends where brick on edge wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.5.7 Protection of brick work

The brick wall shall be protected and covered with gunny bags or water proof sheets from the effects of inclement weather, rain, frost, etc., during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffits of openings are not damaged.

5.5.8 Curing

All brick works shall be kept moist for 10 days after laying.

5.5.9 Scaffolding
5.5.9.1 Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

5.5.9.2 Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings up to two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one metre in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

5.5.9.3 If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees if any shall have to be borne by him.

5.5.9.4 All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer.

The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

5.6 Stone masonry

5.6.1 General

All aspects of the work shall be in conformity with the "Code of Practice for Construction of Stone Masonry, IS: 1597 (Part-I & II)-1992. Relevant clauses under brick work, such as setting out, making chases, openings, fixing frames and plugs, protection, curing, scaffolding etc., shall apply to stone masonry and concrete block masonry.

5.6.2 Mortar

The mortar used shall be as specified in the Schedule of Items or drawing.

5.6.3 Holes and Plugs

Holes in stone walls shall be left for water supply, plumbing, sanitation, electrification, etc., where shown on drawings or ordered by the Engineer as the work proceeds. These holes shall, on completion, be made good to match with the adjoining wall. The Contractor shall provide and fix wooden plugs, water supply piping and electric conduit pipes etc. where so specified.

5.6.4 Random rubble masonry
5.6.4.1 Laying

All stones shall be wetted and cleaned of all dust and loose materials before laying. Stones shall be laid on their natural beds, fitted carefully to the adjacent stones to form neat and close joints fully packed with mortar and chips and spalls of stone may also be used wherever necessary to avoid thick mortar bed or joints. Walls shall be carried to plumb or to the specified batter. Stones may be brought to level course at plinth, window sills and roof levels and the leveling shall be done with concrete comprising of 1 part of the mortar as used for the masonry and 2 parts of 20 mm down graded hard stone chips at no extra cost. Bond shall be provided by fitting in closely the adjacent stones and by using bond stones running through the thickness of wall in a line from the face to back with at least one bond stone, or a set of bond stones, for every 0.5 sq.m. of the wall surface. Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints.

5.6.4.2 Quoins

Quoins shall be of selected stones, neatly dressed with hammer or chisel to form the required angle and laid header and stretcher alternately. No quoin stone shall be smaller than 0.025cum (25dcum in volume and it shall also not be less than 300mm in length, 25% of them being not less than 500 mm in length).

5.6.4.3 Joints

The stones shall be so laid that the joints are fully packed with mortar and chips and face joints shall not be more than 20 mm thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of lying, otherwise the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.5 Coursed rubble masonry - First sort

5.6.5.1 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar, chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the quantity of stone masonry. The masonry in a structure shall be carried up regularly but where breaks are unavoidable, the joints shall be raked back at an angle not steeper than 45 degree. Toothing shall not be allowed.

5.6.5.2 Bond Stones
Bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.6.5.3 Quoins

The quoins, shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid stretchers and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10 cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

5.6.5.4 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.6 Coursed rubble masonry - Second sort

5.6.6.1 Laying

Shall be as specified in 5.6.5.1 except that the use of chips shall not exceed 15% of the quantity of stone masonry, and stone in each course need not be of the same height but more than two stones shall not be used in the height of a course.

5.6.6.2 Bond stone, quoins

Shall be as specified for first sort respectively.

5.6.6.3 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than 2 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.7 Hollow concrete block masonry

5.7.1 Construction of hollow concrete masonry shall be done in accordance with procedures laid down in IS: 2572-1963. General procedures for construction shall conform to IS: 2212-1991 except for the following:

5.7.2 Storage, handling and preparation

The blocks shall be stored in stable stacks over planks or other supports with sufficient care taken to prevent ingress or moisture.

Blocks shall be handled carefully to avoid cracking. All damaged units shall be rejected and removed from site.

Blocks need not be wetted before or during placement. Unless the climatic condition so require, the top and sides may be slightly wetted.
5.7.3 Mortars

Mortar for use in hollow concrete block masonry shall be made from cement, slaked lime and sand unless otherwise specified. The mix preparation shall be as recommended in Table-I of IS: 2572-1963. Preparation of mortar shall be in accordance with IS: 2250-1981.

5.7.4 Laying

Laying of block for first and subsequent courses and requirements of horizontal and vertical joints shall be as described in IS: 2572-1963. Use of hollow blocks in foundations shall be avoided. Use of blocks filled with sand and blocks filled with 1:3:6 concrete for foundation courses, plinths and basements shall be done with approval of Engineer. Closure blocks of superstructure shall have all openings battered with mortar. A course of solid concrete block masonry shall be provided under door and window openings or a 10 cm thick precast concrete sill block shall be provided under windows. This course shall extend at least 20 cm beyond the openings on either side. Solid blocks or hollow blocks filled with 1:3:6 concrete shall be used for jambs or fixing of hold fasts etc., Similarly solid blocks or U-shaped blocks filled with 1:3:6 concrete shall be used for roof course. They shall be finished smooth at top with 1:3 cement mortar and covered with a coat of crude oil, craft paper or oil paper for free roof movement.

5.7.5 Bond

Wherever two walls intersect, bond between at least 50% of the units intersecting shall be provided. If intersecting walls are laid separately pockets shall be left in the first wall at a maximum vertical spacing of 20 cm for the corresponding course of second wall to be built into these pockets.

Pilasters shall be of twice the thickness. Hollow blocks shall not be used for isolated piers unless they are filled with 1:3:6 concrete.

6.0 PLASTERING AND POINTING

6.1 Materials

The specification of materials shall conform to the requirements as specified in Part-I.

6.2 Plastering

6.2.1 General

Plastering shall be done in accordance with provisions of IS: 1661-1972. Mix proportions of mortar for plastering and thickness of plaster shall be as given either in the drawing, or as per Schedule of Items or as directed by the Engineer. For special plaster work, necessary admixtures shall be added to mortar in required proportion as per manufacturer's specifications or as specified herein. The thickness mentioned in the Schedule of Items shall be minimum thickness.

6.2.2 Preparation of surface

The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In masonry the joints shall be raked to a minimum depth of 12 mm and cleaned with wire brush. Concrete surfaces to be plastered shall be roughened and hacked to form key for plastering. All plastered surfaces shall be finished smooth with a wooden float in one plane and all internal angles shall be finished slightly rounded. If desired by the Engineer,
any unevenness shall be rubbed down by carborundum stones. The surface to be plastered shall be wetted evenly before the application of plastering. Trimming of projections on brick/concrete surfaces wherever necessary shall be done.

For one coat plastering the plaster shall be laid slightly thicker than the specified thickness and the surface then leveled with flat wooden float to the required thickness. For two coat plaster work, the first coat (usually half of total thickness) shall be applied as detailed above except that the surface shall be left rough and keys formed for the application of second coat. The second coat shall be laid on with a wooden float to the specified thickness and shall be applied a day or two after the first coat has set, but has not dried up.

Cement mortar for plastering work shall be used within 30 minutes after adding water to cement and should be kept agitated at intervals of 20 minutes.

If specified cement punning shall be done over the plastered surface by sprinkling neat cement powder evenly on the surface and rubbed smoothly with a trowel to give a fine coating. The plaster shall be kept wet for at least seven days and protected from extreme temperature and weather during this period.

The arises of doors and windows shall have richer mortar 1:3 in a width of 75 mm on either side or as required at respective location.

6.2.3 Concrete beams, slabs, columns etc. framing into masonry are to be plastered along with masonry walls with these edges wrapped with chicken wire mesh of gauge 24. Overlapping of mesh shall be minimum 75 mm on either side of the edge of the concrete element. Minimum lap for chicken wire mesh shall be 50 mm.

6.3 Cement Pointing

6.3.1 Where shown on drawing, Schedule of Items, or as directed by the Engineer, exposed brick faces shall be cement rule pointed. The mortar shall be raked out of the joints to a depth of 12 mm. The dust shall be brushed out of the joints and the wall well wetted.

Unless otherwise specified the pointing shall be made with cement and sand mixed in proportion 1:3. The joints of the pointed work shall be neatly finished truly vertical and horizontal or as directed and the lines shall be kept wet till the cementing material has set and become hard. If required, the whole brick face shall be rubbed and polished with fine grade of carborundum stones. Particular care shall be taken to see that no brick face or brick edge is damaged during this work.

6.3.2 Flush pointing

The mortar shall be pressed into the joints and shall be finished flush and levelled. The edges shall be neatly trimmed with trowel and straight edges.

6.3.3 Ruled pointing

The joint shall be initially formed as for flush pointing and then, while mortar is still green, a groove of required shape and size shall be formed by running a forming tool straight along the centre line of the joint till a smooth and hard surface is obtained. The vertical joints shall also be finished in similar way. The pointing line shall be uniform in width and truly horizontal in case of floors and ceilings.

6.3.4 Cut or weather struck pointing
The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 3mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

6.3.5 Raised and cut pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6mm raised and width 10mm or more as directed. The pointing shall be finished to a smooth but hard surface. The superfluous mortar then shall be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all the mortar.

Curing

The pointing shall be kept wet for 7 days. During this period it shall be suitably protected from all damages.

6.3.6 Pointing on brick flooring

Specification for this shall be conforming to under sub head "Pointing".

6.3.7 Pointing on random rubble stone masonry

In such pointing, the mortar shall be simply struck off with a trowel and the work left showing the natural irregularities in line and surface of the stones themselves. Other specifications shall remain same as per para 8.3 under sub head "Pointing".

6.4 Rough Cast Concrete Facing

6.4.1 The surface shall be prepared as for Cement plaster and then 2 cm backing coat of cement sand mortar 1:3 shall be applied. Subsequently, when the backing coat is in plastic state, a top coat 12 mm average thick cement and stone chips mixture in proportion 1:3 (stone chips 10 mm size and below) shall be applied by dashing the mixture on top with trowel to produce uniform rough texture. The mix shall again be dashed over the vacant spaces if any. The surface shall afterwards be cured for 10 days. After curing, the surface shall be brushed with hard wire brush to remove loose chips from the surface. A coat of cement wash shall then be applied, the cost of which shall be included in the rate of the item.

6.4.2 Rendered sand faced cement plaster

The surface shall be prepared as for cement plaster. The backing coat shall be 12 mm thick of cement plaster proportion 1:4 (1 cement and 4 sand) and keys shall be formed on the surface. After curing this coat sufficiently, the finishing coat 6 mm thick consisting of grey cement and screened coarse sand to required gradation (1:3) shall be applied and finished to the desired texture to the satisfaction of the Engineer. The surface afterwards shall be cured for 7 days.

6.4.3 Plaster moulding

Where specified, plaster moulding shall be strictly as per drawings and details, and shall run clean and true from proper templates and moulds, to the entire satisfaction of the Engineer. Rates shall include for brick or concrete cores and for any necessary dabbing in cement mortar or brick or metal lath curing and final finish as desired. Where desired, all angles in internal moulding work shall be covered to a radius of 50 mm or as directed without any extra charges.
6.4.4 Floating coat with neat cement

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 whole surface is covered with neat cement coating. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to cement.

6.4.5 Pebble dash plaster

Specification shall be same as that for rough cast concrete facing vide 8.4.1 except that pebbles or graded crushed stone, of size 10mm to 20mm or as specified/directed by the Engineer, shall be well washed and drained and then dashed/thrown wet on the plaster surfaces while it is still plastic, using strong whipping motion at right angles to the face of wall, pressed flat and filling uncover parts by hand so that finished surface represents homogeneous look. The finished surface shall be lightly tapped with a trowel to ensure good bond.

6.5 Punning with Lime or Plaster of Paris

6.5.1 Lime Punning

Lime punning shall be carried out with best quality approved lime. Lime shall be properly stirred, tempered with water to form a homogeneous mass and strained through fine cloth. The punning shall be laid and rubbed and troweled to an uniform smooth even finish using special trowels. Any unevenness shall be rubbed down with fine sand paper. The plaster must be dry before the lime punning is applied. The punning shall be kept wet for a period of 7 days. The lime paste shall be kept wet until use and no more quantity than can be consumed in 10 days shall be prepared at a time. No portion of the surface shall be left out initially to be patched up later on.

6.5.2 Plaster of Paris punning

This shall be provided by using the best quality of plaster of Paris from approved manufacturer. Unless otherwise specified same procedure as for lime punning shall be followed for getting uniform smooth finish.

7.0 FLOORING, PAVING & FACING

7.1 Scope

Flooring, Paving and facing includes flooring, skirting and dado of various types encountered in plants, buildings, pavements etc. as described under respective heads. For the items which have not been covered up in this chapter completely or covered up only partly, specifications suggested by the manufacturers for the materials, surface preparation, workmanship and all other byeworks etc., shall be strictly followed. In addition to this the entire job will have to be carried out as per direction of the engineer, which shall be final.

7.2 Materials

Materials shall conform to Part-I of this series.

7.3 General
Flooring, skirting & dado may have to be done in discontinuous strips or areas to suit the needs of erection and commissioning of equipment. Flooring shall be done in close co-ordination with erection of equipment or other services and shall keep pace with the demands in respect of commissioning of individual equipment. No claims for extra shall be tenable for reasons of discontinuity of work or delay in having areas available for work.

Unless otherwise specifically included in the Schedule of Quantities or stated in the description of work, no extra shall be payable for works such as forming coves at internal angles, nosing at plinths, steps, window sills and stair treads, dishing in bath rooms, toilet & other places and cutting to line and fair finish to top edge of skirting and dado. Thickness mentioned shall be the minimum.

7.4 Sub-base

Flooring at ground level having sub-base of sand or earth as specified shall be laid in layers of 15 cm, watered and consolidated by rolling with hand roller or ramming with iron rammer and with butt ends of the crow bars. When filling reaches the required level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement later. The thickness of the sub-base shall be as specified either in the drawing or in the Schedule of Items.

7.5 Subgrade

The surface shall be brought to the desired level before subgrade is laid, loose pockets shall be filled up and whole surface shall be consolidated by tamping. Vegetable growth and other decomposed matter, rubbish etc., shall be removed.

7.5.1 Hard core subgrade

Where hardcore subgrade is specified, stone/slag boulders/laterite boulders shall be laid closely stacked together, the longer edge being laid vertically. All interstices shall be filled with smaller particles of the same material or with gravel or red earth. The top surface shall be spread with loose moorum sufficient to cover the gap and to achieve uniform top surface. The surface shall then be adequately watered and rolled by roller.

Hard core shall be laid to form the desired slope in the finished floor.

7.5.2 Brick Khoa subgrade

Over burnt bricks shall be used for getting brick khoa as per sizes described in Schedule of Items. The khoa shall be laid uniformly and rammed in dry and wet conditions so as to get a uniform compact surface.

7.6 Cement Concrete Flooring with Integral Finish

Cement concrete shall be mixed, laid, consolidated and cured as described in Chapter "Concrete". Laying of concrete shall be done in alternate panels. The size and division of panels shall be as per direction of Engineer. The mix or grade of concrete shall be as specified in Schedule of Items.

The finished surface may be rendered smooth by trowel finishing to provide an appearance of fine and smooth textured surface and in panels or in geometric pattern as specified in Schedule of Items or as directed by Engineer.

7.7 Concrete Flooring with Granolithic Finish

(Artificial Stone Flooring)
Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete. The subgrade shall be either brick khoa/lime concrete/cement concrete, as specified. Flooring shall be laid and finished according to IS: 5491-1967.

7.7.1 Thickness

Unless otherwise mentioned the thickness of flooring including topping shall be either 25 mm or 40 mm or 50 mm as shown on drawing/Schedule of Items. The net thickness of topping shall be 6 mm for 25 mm thick floor, 10 mm for 40 mm and 12 mm for 50mm thick floor. An additional allowance of 2mm in thickness of topping shall be made for cutting and grinding margin wherever polishing is specified in the item. The rate of the item will be inclusive of this.

7.7.2 Mix

For base or under bed course, the mix shall be 1:2:4 concrete, unless specified otherwise. The mix of the topping shall consist of 1 part cement :1 part coarse sand : 1 part coarse aggregated by volume or 1 part cement and 1 part stone chips. The coarse aggregate shall very hard like granite and well graded and size of chips shall be 3mm for 6mm topping & 6mm to 3mm for 10mm or more thick topping. Minimum quantity of water to get workability shall be added.

7.7.3 Laying

a) Laying of monolithic topping

The concrete base or underbed shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The surface shall remain sufficiently rough to take the finish.

To prevent construction cracks, the panels shall be divided in square or rectangular pattern. For floor finish of 40mm thickness or above, the maximum panel area shall be 2.5 sq.m. with none of the sides exceeding 2.5m, however for lesser thickness these shall be 1.5sq.m. and 2.5m respectively. The dividing strip may be aluminium or glass or as specified and shall have the same depth as that of floor. Within about 2 to 3 hours of laying the base while it is still fully 'green' the topping shall be laid evenly to proper thickness and grade. The topping shall be pressed firmly and rigorously to form full bond with the base/underbed.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly troweled to remove all marks and shall be left for sometime till moisture disappears from it. Fresh quantity of cement @ 2.2 Kg per sq.m. of the flooring shall be mixed to form a thick slurry and spread over the surface while concrete is still green. The cement slurry then shall be floated even & smooth. Polishing, if specified, shall be done with polishing machine and the portion where machine cannot be used manually to the satisfaction of the Engineer. If specified so the surface of the flooring shall be finished ribbed, chequered or laid in slope without any extra cost unless specified so in the item. On completion, the floor shall be kept flooded with water for 10 days and shall be adequately protected before it is sufficiently hard.

(b) Laying of topping separately on hardened base
The sub base shall be laid as in clause 7.7.3. The surface of the base concrete shall be thoroughly brushed and cleaned free from all dirt, mortar droppings and laitance etc.. Where the surface has hardened too much, chipping or hacking of the surface may be necessary. The surface shall then be wetted with water for several hours and surplus water mopped. Neat cement slurry at 2.75Kg/sq.m. of surface shall be brushed into the clean surface. The topping then shall be laid as described in clause 7.9.3.

7.7.4 General

The junction of the floors with all plaster dado or skirting shall be rounded of with 1:1 cement sand mortar & polished, if specified or shown in drawing.

7.7.5 Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to use during this period.

7.7.6 Grinding & finishing

Where grinding is specified, it shall start only after the finish has fully set. The grinding shall be done with carborundum stone of No. 60, then No. 80 and then 120 as per the method as specified in in-situ mosaic flooring. After final polishing, the floor shall be rubbed with oxalic acid and then wax polished.

7.8 Dado & Skirting Work (Grey Cement Skirting/Dado)

A backing coat of 12 mm thick and 15 mm thick shall be applied on walls after proper dabbing of the surface for a finished thickness of 18 mm and 21 mm thick respectively, with cement plaster of proportion 1:4 (1 cement and 4 approved quality sand) or as specified. Over this a top coat 6mm/7mm thick consisting of one cement to one stone chips 3 mm nominal size shall be applied. If grinding and polishing specified, the same shall be done as per granolithic flooring with carborundum stones.

7.8 Flooring & Facing with Redoxide of Iron (Red Artificial Stone Flooring)

It shall consist of an underbed or base course and topping over already laid & matured concrete subgrade.

7.9.1 Thickness

Unless otherwise specified the total thickness of the flooring shall be either 40 mm or 25 mm of which the topping shall not be less than 6 mm (net) for 25 mm thickness and 10 mm (net) for 40 mm thickness. The topping shall be of uniform thickness, the underbed may vary in thickness to provide necessary slopes. For vertical surfaces the total thickness shall be 18 mm, of which the topping thickness shall be 6 mm (net). Where grinding (cutting) & polishing is specified a minimum allowance of 2 mm shall be kept for cutting & polishing so that the net specified top thickness is achieved. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm or as shown in the drawing.

7.9.2 Mix
i) **Course or base course**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 or 4 parts coarse sand by volume as specified in the item.

ii) **Topping course**

For the topping white cement and red oxide of iron pigment powder shall be dry mixed thoroughly (generally 10:1 by weight) to produce the desired colour when laid. The mix shall then be prepared with 1 part white cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

### 7.9.3 Laying

The underbed shall be laid in panels of maximum area 2.5 sq.m. each and no side shall be more than 1.5m long. For outdoor locations the maximum area shall be 2.0 sq.m. or as specified. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. Aluminium or glass dividing strips shall be used as forms. The underbed shall be laid compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat ‘Green’ but firm enough to receive the topping. The surface of the underbed shall be roughhead for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by troweling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg of the mixture shall be consumed/per sq.m. for horizontal surface, and 1.0 kg for vertical surface.

### 7.9.4 Grinding & polishing

Where grinding & polishing specified, the same shall be done 36 hours after laying when the surface has hardened sufficiently. It shall be polished with polishing stone, in sequence of different grades of carborundum stones (first No. 60, then No. 80 & then No.120) till a smooth shiny surface to the satisfaction of the Engineer is achieved. After final polishing, the finished areas shall be rubbed with oxalic acid and then wax polished.

### 7.10 Terrazzo Flooring & Facing

**General**

The terrazzo work shall be done by approved firm or specialists. Marble chips used for facing coat of terrazzo work shall be of best quality (from Dehradoon or other approved source) and of uniform tint and colour and shall be approved by the Engineer before using in the work. All terrazzo work shall be polished on completion followed by a final wax polish of approved quality.

Terrazzo work shall be done either cast-in-situ or with precast tiles as specified in the Schedule of Quantities Unless otherwise specified thickness for cast-in-situ terrazzo work shall be 25 mm including base course and for tiles 20 mm excluding mortar bed.

### 7.10.1 Cast-in-situ terrazzo flooring
It shall consist of an underbed and a topping laid over an already matured concrete subgrade.

7.10.1.1 Thickness

Unless specified otherwise, the total thickness of the finished flooring shall be either 25 mm or 40 mm of which the topping shall be minimum 6 mm (net) for 25 mm and minimum 10 mm net for 40 mm flooring. A minimum allowance of 2 mm in the topping shall be kept for grinding and polishing so as to achieve the minimum specified thickness of topping. All junctions of vertical with horizontal planes shall be rounded neatly to uniform radius of 25 mm or as shown in the drawings.

7.10.1.2 Mix

i) Underbed course

The underbed for floors and similar horizontal surface shall consist of a mix of 1 part cement, 2 parts sand and 4 parts stone chips by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only minimum water to be added to give a workable consistency.

ii) Topping

Topping shall consist of cement (grey or white) as specified with or without colour pigment, marble powder and marble chips. The proportion of cement and marble powder shall be 3 parts of cement to one part of marble powder by weight. The proportion shall be inclusive of any pigments added to the cement. The proportion, to which pigments are mixed with grey or white cement to obtain various shades for the binder, shall be as specified in Table-I of IS: 2114-1984.

The proportion of marble chips and cement marble powder mix shall be 7 parts of marble chips to 4 parts of cement marble powder mix mixed by volume. Care shall be taken to ensure an even and uniform disposition of the marble chips.

7.10.1.3 Laying

i) Laying of underbed

The underbed shall be laid in panels in the same manner as that for artificial stone flooring. The panels shall not be more than 2 sq.m. in area of which no side shall be more than 2.0 m long. Cement slurry @ 2.75 kg/sq.m. shall be applied before laying over cement concrete/RCC surface/plastered surface.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping. In case of in-situ dado work, the sections shall not be more than 60 cm x 60 cm and the aluminium, glass or any other material strips provided similarly.

ii) Laying of topping

After laying, the underbed shall be leveled compacted and brought to proper grade with screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully
bonded with the underbed. The terrazo surface shall be tamped, troweled and brought true to the required level by straight edge and steel floats in such a manner that maximum amount of marble chips come up and are spread uniformly over the surface and no part of the surface is left without the chips. Excessive troweling should be avoided in early stages lest too much cement may come up the surface leading to surface cracking and requiring more grinding to expose marble chip.

7.10.1.4 Curing

The surface shall be left dry for air curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for seven days.

7.10.1.5 Grinding & polishing

Grinding and polishing shall be done either by hand or by machine. In case of manual grinding, the process of grinding shall begin after 2 days while in case of machine grinding the process shall start after seven days after completion of laying. First grinding shall be done with carborundum stone of 60 grit size. The floor shall then be washed and cleaned to remove mud and grindings, a grout of cement and colouring pigment in same proportion of the topping shall be applied to cover the pin holes. The surface shall be cured for 5 to 7 days and then ground with machine fitted fine grit blocks (No. 120). The surface shall be again cleaned and repaired as mentioned above and shall be cured for 3 to 5 days. Finally the third grinding shall be done with machine fitted with fine grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible/possible rubbing and polishing by hand shall be done in the same manner as specified for machine polishing except that carborundum of coarse grade (No. 60, 80 and 120) for first, second & final polishing. After the floor is polished to the satisfaction of the Engineer, it shall be rubbed with oxalic acid and finally wax polished with 'Mansion' or similar approved floor polish to the entire satisfaction of Engineer. For good result, wax polishing shall be applied on the surface with the help of soft linen over a clean and dry surface and then the polishing machine fitted with bobs shall be run over it. Clean saw dust shall be spread over the floor surface and the polishing machine again operated so as to remove excess wax and leave glossy surface. Floor shall not be left slippery.

7.10.2 Terrazzo cast-in-situ facing, skirting and dado

The work shall be carried out in the same manner as that for terrazzo cast-in-situ floors except that the base or bedding course shall consist of 1:3 cement mortar (1 cement & 3 medium sand) of 12 mm or 15 mm or 20 mm thickness for total thickness 18 mm or 21 mm or 26 mm respectively. As specified earlier, the bedding course shall be laid in panel (not more than 60 cm x 60 cm) divided by glass/ aluminium strips. The topping shall be of 6 mm thick finished and shall be laid when the backing plaster is still green. Special care shall be taken to see that the surface are properly cured.

7.10.3 Terrazzo tile finished flooring/facing

The work will consist of manufactured terrazzo tile and an underbed.

7.10.3.1 Thickness
Unless otherwise specified, the total (net) thickness including the underbed shall be 40 mm for flooring and other horizontal surface and 32 mm for vertical surfaces like dado/skirting. The necessary allowance for cutting and grinding shall be kept to have the specified finished thickness.

7.10.3.2 Tiles : Terrazzo

The tiles shall, unless specifically permitted in special cases, be machine made under quality control in a shop and shall be subjected to minimum hydraulic pressure of 140 kg per sq. cm.

The tiles shall be composed of a backing and topping. The finished thickness of upper layers shall not be less than 5mm for size of marble chips upto 6m size and not less than 6mm for size of marble chips upto 20mm size.

The ingredients for topping shall be same as cast-in-situ terrazzo. The thickness of the topping, as specified above, shall be net after grinding & polishing. First grinding shall be given to the tiles at the shop before delivery.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles.

7.10.3.3 Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 3/4 parts coarse sand mixed with sufficient water to form a stiff workable mass. The thickness of underbed for the flooring shall be 20mm unless otherwise specified. For skirting and dado and all vertical surface it shall be about 12 mm thick and composed of 1 part cement 3 parts coarse sand.

7.10.3.4 Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The base surface shall be roughened for better bond. Before laying the underbed, over the base/subgrade, a coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or cement slurry applied at 4.4Kg of cement per sq.m. and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moistened allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed. If desired dividing strips as specified under Cl. 7.10.1.3 may be used for dividing the work into suitable panels.

7.10.3.5 Grinding and polishing
Procedure shall be same as in-situ terrazzo finished flooring. Grinding shall not commence earlier than 14 days after laying of tiles.

7.11 Glazed Tile Finished Flooring & Facing

This finish shall be composed of glazed earthen tiles with an underbed laid over a concrete or masonry base.

7.11.1 Thickness

Unless specified the total thickness shall be 21 mm for flooring & 18 mm for dado/skirting for the underbed.

The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

7.11.2 Tiles : Glazed

These shall conform to the requirement of IS : 777. The tiles shall be of earthenware, covered with glazed white or coloured, plain or with designs, of 149 mm x 149 mm or 99mm x 99mm nominal sizes and 5,6 & 7 mm thick unless otherwise specified. Specials like internal and external angles, beads, covers, cornices, corner pieces etc., shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform, and fractured section shall be fine grained in textures, dense and homogeneous.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

7.11.3 Mix : Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand mixed with sufficient water or any other mix if specified and shall be 12mm thick minimum or as specified.

7.11.4 Laying & finishing

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. Before laying the underbed, over the base/subgrade a coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The joints shall be practically invisible and filled with non-staining white cement/white cement mixed with pigment for coloured tiles. Internal angles shall be provided with ‘specials’. Drains shall be provided with ‘specials’. The tiles shall be thoroughly cleaned after completion. The tiles shall be laid to the slope specified in the drawings and truly vertical on walls when used as skirting.

7.11.5 Curing & cleaning

After flush pointing the joints, the surface shall be cured for 7 days by keeping it wet. The surface shall be then cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

7.12 Marble Flooring
7.12.1 Thickness

Unless specified otherwise the underbed shall be average 20 mm for flooring and 12 mm thick for vertical surfaces. The slabs may be 20 mm, 25 mm, 30 mm or 40 mm thick as specified.

7.12.2 Marble slab

The slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws, angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of plus or minus 5 mm in dimensions and plus or minus 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm. The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

7.12.3 Mix: Underbed

The underbed, unless specified otherwise for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 4 parts coarse sand mixed with sufficient water to form a stiff workable mass and shall be on 20mm thick bed. For skirting and dado and all vertical surfaces it shall be 12 mm thick and composed of 1 part cement and 3 parts coarse sand.

7.12.4 Laying

The sides and top surface of the slabs shall be machine rubbed with coarse sand stone and washed clean before laying. The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry at 4.4 Kg of cement per sq.m. shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

7.12.5 Polishing, finishing

Fine chiseling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under terrazzo flooring. However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

7.13 Marble in Facia or Dado

Marble tiles of approved shade, variety, size and thickness as specified in the item shall be used. They shall be of selected quality, dense, uniform and homogeneous in texture and free from cracks or other structural defects. The exposed face shall have no unsightly stains, veins and defects. They shall have uniform milky white or coloured shade or patterns of colours approved by the Engineer before ordering the tiles. The surface shall be fine polished and sides machine cut, true to square.
When a single course of marble slab is to be fixed as in dado etc., the slabs shall be fixed as described below:

Mortar pads of 1:3 C.M. (1 cement : 3 coarse sand) of uniform width shall be stuck on to the wall at close intervals and the marble slabs shall be pressed on to them firmly. The remaining cavities if any shall then be filled with thin grout of cement mortar of the same proportion. The sound coming, on gently tapping of the slab, will indicate if there are hollows. When the hollow cannot be filled with grout and the finished slab continues to give a hollow sound on tapping, the slab shall be removed and reset. For the facia work where more than one course is required the marble slabs shall be of matching stand and veins to form architectural pattern as per drawings and shall be fixed in the same way as described above except for the horizontal joints of the slabs, where adjacent slabs shall be held together by a brass pin passing through a hole drilled into the slabs. In addition, wrought iron/dowels shall be provided to anchor the slabs to the wall. The metal cramps shall be counter sunk into the joints of the slab and it shall be located about a metre apart subject to a minimum of one for each slab for each horizontal joint.

The facing shall be fixed truly in plumb and in perfect line or curves as shown on the plans. The courses and joints shall be as directed by the Engineer. The surface shall be protected from sun and rain and cured for 10 days and shall be finally polished with carborundum stones as for skirting & dado of cast-in-situ terrazzo.

7.14 Flooring/Paving with Hardener like Ironite

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'Green'.

7.14.1 Thickness

Unless otherwise specified in the Schedule of Items, the total thickness of the floor with metallic hardener finish shall be 40 mm or 50 mm of which the topping shall be 10 mm (net) for 40 mm & 12 mm (net) for 50 mm

7.14.2 Material (metallic hardener)

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the Engineer, actual samples shall be tested.

7.14.3 Mix

Unless otherwise specified, the mix for underbed shall be of 1:2:4 concrete and stone chips shall be 12 mm down grade. For topping the proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

7.14.4 Laying & finishing

The underbedding course of base course shall be laid as per specification of laying underbed for Red artificial stone flooring. The surface shall be roughened by wire brush as soon as possible. The finish top coat shall be laid while the concrete base is still fairly 'green' within about 3 hours of laying of the later. The finish shall be of uniform and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed
firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smooth with steel trowel.

7.14.5 Curing

The finished floor shall be cured for 7 days by keeping it wet.

7.15 Chemical Resistant Tiles Flooring / Facing
(Either of natural stone or prepared tiles)

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry. The Contractor shall get it done by specialised manufacturer & get guarantee of its performance.

7.15.1 Tiles

The chemical resistant tiles as detailed in the Schedule of Items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 kg/cm². The surface shall be abrasion resistant and durable.

7.15.2 Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have same chemical resistant properties as that of tiles. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer’s specification approved by the Engineer.

7.16 Chemical Resistant in Situ Finished Flooring/Facing

Chemical resistant in situ finish shall be as called for in the Schedule of Items. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the owner in addition to his own guarantee.

7.17 Acceptance Criteria

The Contractors shall satisfy the Engineer specially for the workmanship of the following finished floor:

(a) Level, slope, plumb as the case may be
(b) Alignment of joints, dividing strip etc.
(c) Colour, texture
(d) Surface finish
(e) Thickness of joints including the workmanship in joints.
(f) Details at edges, junctions etc.
(g) Performance
(h) Precautions specified for durability.
8.0 WOOD WORK

8.1 General

Wood work shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind. Rebates, roundings and mouldings as shown in drawings shall be made before assembling. Exposed work shall be finished smooth with well planed faces.

All assembly of shutters of doors, windows, ventilators and frames thereof shall be exactly at right angles. In the case of frames, the right angle shall be checked from the inside surfaces of the respective members.

All door and window frames shall be clamped together so as to be square and flat at the time of delivery. Door frames without sills shall be fitted with temporary stretchers.

Horns of frames and other parts that go into or butt against the masonry, shall be protected against moisture and decay with two coats of coal tar or other approved protective material.

All surfaces of the door, window and ventilator frames and shutters which are required to be painted ultimately shall be covered evenly by brush with a priming coat of approved primer. In the case of doors to be polished or varnished, a priming coat of approved polish or varnish shall be given before delivery. No primer shall be applied to the wood work until it has been inspected and passed by the Engineer.

8.2 Joinery

All heads, posts, transoms and mullions etc., of doors, windows and ventilators shall be made out of single pieces of timber only. The heads and post shall be through- tenoned into the mortices of the jamb posts to the full width of the latter and the thickness of the tenon shall be not less than 1.25 cm. The tenons shall be close fitting into the mortices and pinned with corrosion resisting metal pins not less than 8 mm diameter or with wood dowels not less than 10 mm diameter. The depth of rebate in frames for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm. Unless otherwise specified, all joints shall be mortice and tenon joints with the ends of the tenons exposed to view. Joints shall fit truly and fully without fillings. The contact surfaces of tenons and mortices shall be treated, before putting together, with an approved adhesive conforming to I.S :848- 1974 and 851-1978.

8.3 Shrinkage & Tolerance

The arrangement, joining and fixing of all joinery work shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work.

The tolerance on overall dimensions shall be within the limits prescribed in IS : 1003 (Part 1 & 2)-1983 to 1991.

8.4 Fixing
Door and window frames shall generally be built in at the time the walls are constructed. Alternatively, where permitted by the Engineer, the frames may be subsequently fixed into prepared openings for which purpose holes to accommodate the holdfasts shall be left at the time of construction. Where the frames are subsequently fixed into prepared openings in the wall such openings should be 25 mm more than the overall width of the door, window or ventilator frame to allow minimum 12 mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door care shall be taken to see that at least 6 mm space is left between the door and the finished floor. The M.S. clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 or (1:2:4 mix) with 20 mm down graded stone chips after holding the frame in proper position to the line, level and plumb.

The size of the concrete block shall be 250 x 125 x 85 mm unless otherwise specified.

8.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with boiling coal tar or 2 coats of wood preservative treatment like hot solingnum or creosite oil etc. before fixing the frame in position.

8.6 Fittings

Unless otherwise specified, three holdfasts shall be fixed on each side of a door frame, one at the centre point, and the other two at 30 cm from the top and the bottom of the door frames. In the case of windows and ventilators, a pair on each side shall be fixed at quarter points of the frames. Unless otherwise specified the holdfasts shall be of mild steel plate 40 x 3 x 225 mm long, fish tailed at one end and screwed to the frame in the formed rebates.

Generally, each door shutter shall be fixed to the frame with three hinges of approved manufacture, one at the centre and the other two approximately 24 cm from the top and bottom of the shutter. Each window shutter shall be fixed to its frame with two hinges at the quarter points.

Locks, handles, door closers, stoppers etc., shall be fitted as shown in drawing or described in the Schedule of Items.

8.7 Doors, windows & ventilators etc.

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003 (Part 1&2)-1983 to 1991 Table- III or as shown on the drawings. The work shall be carried out as per detailed drawing. The wooden members shall be planed, smooth and accurate. They shall be cut to the exact shape and size without patching or plugging of any kind. Mouldings, rebates, curves and roundings etc. shall be done as shown in the drawing before the pieces are assembled into the shutter.

The thickness of stiles and rails etc shall be as per IS: 1003 (Part 1&2)-1983 to 1991 unless otherwise specified in the item of works. These shall be properly and accurately mortised and tenoned. Rails which are more than 180 mm in width shall have 2 tenons. Stiles and rails shall be made out of single piece upto 200 mm in width. In case more than one piece of timber is used for members exceeding 200 mm width, they shall be joined with a continuous tongued and grooved joint, glued together and reinforced with rust proof metal dowels or headless pins. The tenons shall pass clear through stiles. The stiles and rails shall have a 12 mm groove, unless otherwise shown in the drawing, to receive the panel. In case of double shutters the rebate at the closing junction of the two shutters
shall be as per clause 5.5 of IS: 1003-1991 or as shown in the drawing. Primer coat shall not be put before shutters are passed by the engineer.

8.8 Panelled Shutters

These shall conform to IS: 1003 (Part I)-1991. Timber panelled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, hard board or asbestos cement board.

Stiles, rails and panels in door shutters shall be of the same species of wood.

Timber panels shall be of minimum width of 150mm. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. No single panel shall exceed 0.5 m² in area. Timber panels shall be fixed only with grooves but additional beadings may be provided either on one side or both sides.

Unless otherwise specified thickness of panel for 35mm thick shutter shall be 15mm and for 40mm and above thick shutter, it shall be 20mm. For 25mm thick shutter, panel thickness shall be 12mm.

Apart from timber panels other materials like plywood, Block board, particle board, Hard board and Asbestos cement may also be used for panelling purpose and shall be fixed with grooves or beading or both as per provisions made in IS:1003 (Part-1)-1991.

Timber suitable for manufacture of door shutter have been grouped under class a,b,c & d in Table 1 of IS: 1003 (Part-1)-1991.

8.9 Glazed Shutters

The openings for glazed shutters shall be rebated and moulded out of solid timber. Plain sheet glass for panels shall be of approved quality as specified. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass. Unless otherwise specified glass panes shall be fixed by means of moulded beads and suitable MS panel pins. A thin layer of putty shall be applied between glass panes and sash bars and also between glass panes & beading.

8.10 Flush Door Shutters

Unless otherwise specified, flush door shutters shall have a solid/cellular core, a teak wood frame, and shall be faced with approved quality of plywood on both faces. The core and stock shall be made from well seasoned approved timber and treated with approved preservatives. The plywood faces shall be glued on to the solid/cellular core with waterproof glue under pressure and heat. The construction of flush doors shall be such that no difficulty should arise in fixing mortice locks, hydraulic door closers etc. The shutters shall be rebated in the case of the double leaf doors. Where specified flush doors shall be provided with vision panels, rectangular/ round or louvered.

If specified so, the flush door shall be solid block board core or solid particle board core construction. The workmanship and overall finish shall be of very high standard and shall conform to IS:2191 (Part 1&2)-1983 & 2202 (Part 1&2)-1983 to 1991. The shutters shall be procured from approved manufacturer bearing IS certification mark only.

8.11 Other types of shutters
8.11.1 Wooden hand rails

Wooden hand rails shall be of approved quality teak wood fixed to concrete or metal balustrade with concealed steel or metal lugs and bolts as per drg. Joints will be made with concealed crews and dowels. All bends, mitres, coves, moulds etc. will be strictly to proper profile and finally smoothened by sand paper. The hand rail shall be finished with wax or french polish or painting as per direction of the engineer.

8.11.2 Hardware fittings for door, windows & ventilators

All mortice or rim locks, latches, cabinet and wardrobe locks, hydraulic door closers, floor springs etc. shall be of Godrej, Everite make or of similar approved make. The rate shall include for all necessary screws, other adjuncts, fixing in position and is for the completed work. The finish shall be as specified in the schedule of quantities. Door, window and ventilator fittings shall be as per specifications already described. The rates for doors, windows and ventilator shutters shall include the cost of fixing the fittings, with the necessary screws to the shutters and the frame. The cost of fittings only shall be paid separately. Where specified in the schedule of quantities, the cost of fittings shall be included in the rates for doors, windows and ventilator shutters. In such case the contractor shall supply and fix the various fittings strictly to the standard laid down in the schedule of hardware fittings and no separate payment for this shall be made.

8.12 Inspection

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied until the wood work has been inspected and passed by the Engineer. The Engineer shall have the option of rejecting any article or asking for replacement of any article found to be defective or not complying with the requirements of this specification and the relevant Schedule of Items.

9.0 METAL DOORS, WINDOWS AND ROLLING SHUTTERS

9.1 General

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall conform to IS:1038-1983 & 1361-1978 as applicable.

9.1.1 Frames shall be constructed of sections which have been cut to length and mitred. They shall be morticed, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Flash butt welding or any other suitable method which gives the desired requirement, with mitred corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place. All frames shall be square and flat. Door thresholds shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

9.1.2 The Contractor shall first submit for the approval of the Engineer, the name and address of the manufacturer whose metal casements and doors and windows he intends to use, together with typical drawings and specifications, describing the details of construction for each type of door>window/ventilator etc.

9.1.3 All steel doors, windows and ventilators shall be either galvanised or painted. All steel surfaces shall first be thoroughly cleaned free of rust, scale or dirt and mill scale by pickling or similar process and then shall be painted with one coat of an approved primer.
conforming to IS : 102-1962 before despatch. Alternatively they may be galvanised by the "Hot Dip" zinc spray or electro-galvanizing process as described in IS : 1361-1978.

9.2 Fixing

Doors, windows and ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, as laid down in IS : 1081-1960. Holes to accommodate the fixing lugs are to be left or cut, and the casements fixed after all the rough masonry and plaster work have been finalised. The lugs of the casement shall be jammed in cement concrete (15C Mark)/(1:2:4) mix after holding the casement in proper position, line and level.

The width of the clear unfinished opening in the wall should be 25 mm more than the overall width of the door frame to allow for plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 6 mm space is left between the door and the finished floor.

9.3 Fittings

Hardware shall be fixed as late as possible, preferably just before the final coat of paint is applied. It shall be fitted in a workmanlike manner, so that it may not work loose and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation. Where specified, doors shall be fitted with a three-way bolting device which can be operated from outside as well as inside, and a locking system, which can similarly be operated from either side. Solid steel bolt handles shall be provided, one on the outside and one on the inside of each shutter. In case of doors provided with a service door, the lock shall be fitted on the service door. All materials shall be the best procurable and shall be approved by the Engineer.

9.4 Normal Steel Plate Doors

Steel doors may be of the hinged type or sliding/ folding type, single shutter or double shutter, and of single-walled or double walled construction, as specified on the drawings or Schedule of Items. All doors shall be provided with a sturdy frame and hold fasts for fixing into the wall. Unless otherwise specified, the frame shall be prepared from mild steel angles of size not less than 65 x 65 x 6 mm electrically welded at the corners and the shutter shall be made from flat steel sheet of 18 gauge or 1.25mm thickness with a frame of mild steel angles not less than 50 x 50 x 6 mm all round, suitably braced. The whole shutter shall be of welded construction and shall be hung at the sides by means of three or four hinges as specified.

9.4.1 Double Plate flush door shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G or 1.25mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 20G or 0.99mm thick stiffeners, spot welded in position at not more than 150 mm centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper level on lock stiles and rails and shall be reinforced at corners to prevent sagging or twisting. Pairs of double doors shall have meeting style edges bevelled or rebated. Where shown on drawing, or in the Schedule of Items, the doors shall be sound-deadened by filling the inside voids with mineral wool or other suitable approved materials. Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardwares where necessary. Any drilling and tapering required for surface hardware
shall be done at site. Where shown in drawing, provisions, shall be made for fixing glazing, vision panels, louvres etc. Glazing mouldings shall be of 18G or 1.25mm thick steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvre blades shall be V or Z shaped sections.

9.4.2 Single sheet door shutters

Single sheet doors shall be made from best quality 18g/1mm mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semi-tubular edge and central stiffening rail which shall convey the lock and other fixture. The frames shall be made from best quality steel sections. Wherever required or shown on drawings, provision for fixing glass panes, louvres etc., shall be made.

The manufacturing shall done as specified in "Double Plate Flush Door Shutters".

9.5 Pressed Steel Doors

All pressed steel doors shall be obtained from an approved manufacturer. The frame and shutters shall be fabricated from cold rolled or pressed steel sections. Unless otherwise specified, the thickness of all sheets used for frames shall be not less than 5 mm. The shutters shall be made of sheet steel of 2 mm thickness for single shutter doors and double shutter doors with or without service door. The plates shall be adequately stiffened with suitably placed stiffeners.

The double-walled door shutter shall consist of two plates each 2.5 mm thick, separated by a gap of 33 mm in between making an overall thickness of 38 mm or as shown in drawing. The plates shall be adequately stiffened by means of suitably spaced horizontal steel stiffeners.

9.6 Steel Windows, Sashes, Ventilators, etc.

These shall conform to IS : 1038-1983 and IS : 1361-1978 as appropriate and as shown in drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

9.6.1 Where composite unit openings are shown in drawings, the individual window units shall be joined together with requisite transoms and mullions. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown in drawings.

All welds at the corner of casement shall be done by flash butt welding process or any other suitable method which gives the desired requirement and dressed flush on all exposed and contact surfaces.

9.7 Collapsible Gate (Steel)

Mild steel collapsible gates shall be obtained from an approved manufacturer. These shall be of mid bar type made out of double channels each 20 x 10 x 2 mm with 20 x 5 mm diagonals and shall be top hung with roller bearings, and fitted with locking arrangement.

Collapsible gates under 3.0 metre height shall generally have 3 sets of lattices and those over 3.0 metre height, 4 sets of lattices. Guide tracks shall be fitted at the top and bottom, of T-iron 40 x 40 x 6 mm with 40 mm dia bearings in every fourth double channel.

9.8 Steel Rolling Shutters and Grills (DELETED FOR THIS PROJECT)
9.8.1 Unless otherwise specified the shutters shall conform IS:6248-1979. Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

9.8.2 Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods. End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation. Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.3 Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load. Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods.

9.8.3 End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation. Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.5 Manually operated shutters/grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 0.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 sqm in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank/handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule of Item or as desired by the Engineer.

9.8.6 Priming coat of shop coat
Shutters shall be painted with one coat of red lead or zinc chromate primer after they are inspected and found in order and acceptable. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

9.8.7 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc., shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with prevailing Indian Electricity Rules.

9.8.8 Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

9.8.8.1 Field inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

9.9 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

9.10 Aluminium Doors, Windows, Frames

9.10.1 Anodised tubular aluminium doors shall be of approved make and shall be of size and design as per relevant drawing. Unless otherwise specified, the door frame shall be of 101.4mm x 44.6mm and shutter of 50mm tubular extrusions, 3mm thick. The opening arrangement shall be single action or double action as shown in drawing with spring hinges in floor. The glazing shall be 5.5mm thick plain glass panes fixed with necessary gaskets and aluminium beading strip. The door shall be provided with one security lock. The shutters shall be provided with 1.6mm thick 300x150mm push plates and 1.6mm thick 300mm wide kick plate of anodised aluminium for full width of door inside and outside.

The door frames shall be polished and anodized with approved colour. The average thickness of anodic coating shall not be less than 15 microns as per IS: 1868-1982. Door frame shall be provided with approved anchors @ 90 cm c/c maximum for fixing.

9.10.2 Aluminum windows

Aluminum windows and ventilators shall conform to IS:1948-1961 or equivalent as approved by the Engineer. Fixed frame shall be manufactured from aluminum alloy conforming to ISS-HE-9 WP. The fixtures like handles, stoppers, stays, etc., shall also be anodized aluminum and shall be of approved make. Glazing shall be 4mm thick plain glass and shall be fixed with glazing clips and metal putty. It shall conform to IS:1081-1960. Average anodizing coating to windows, ventilators and fixtures shall not be less than 15 microns as per IS : 1868 - 1982. As far as possible sliding type Aluminum windows shall be provided in office building.
9.10.3 All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be shape fit type without visible screws and shall be of sizes to accommodate glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

10.0 GLAZING

10.1 General

Glazing shall be done with plain, frosted, ground glass or wired cast glass, laminated safety glass or toughened glass etc. as shown on drawings, described in the Schedule of Items or approved by the Engineer. The method of glazing adopted shall be such that movement of the structure, to which the securing is done, does not transmit strain to windows, doors or ventilators as the case may be. The work shall generally conform to IS:1081-1960 "Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators". The material for putty shall consist of whiting and linseed oil, raw-mixed in such proportion as to form a paste conforming to IS: 419-1967.

10.2 Doors, Windows and Ventilators

Windows and ventilators shall be designed for putty glazing fixed from outside and glazed doors for fixing from inside. In addition, spring type glazing clips shall be provided at intervals of 30 cm, or as shown otherwise on drawings or described in the Schedule of Items. These shall be inserted into holes drilled in the shutters or frames as the case may be.

All glazing shall be puttied to the shutters of frames with good quality putty in addition to glazing clips. Glass panes shall not be placed directly against the metal/timber. A thin layer of putty shall be even spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by means of teak wood beads for wooden shutters. Glass panes shall be set without springing & shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty etc. shall be smoothly finished to even lines. Figured glass shall be set with smooth side out. After completion of glazing work, all dirt stains, excess putty etc., shall be removed and the glass panes shall be left in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's cost.

10.3 Northlight Glazing

This shall consist of aluminium or steel glazing bars as shown on drawings or described in the Schedule of Item and be subject to approval of Engineer. The glazing parts shall be securely fixed in their frame and shall be weather-proof. All glazing shall be flashed to the surrounding so as to be weather-proof. Glass shall be fixed to the a astragals with glazing clips and putty.

11.0 WHITE WASHING, COLOUR WASHING AND PAINTING

11.1 Scope

This chapter deals with white washing, colour washing, distempering, cement washing, emulsion painting, silicate painting etc., to concrete and masonry surfaces and painting to the wood works and steel works. For the items which have not been completed or partly covered in this chapter, specifications suggested by the manufacturers for the materials,
surfaces preparation, workmanship and all bye works shall be strictly followed and shall be carried out as per direction of the Engineer.

11.2 Materials

Materials shall conform to Part - I

11.3 White Washing, Colour Washing

11.3.1 General

Wherever scaffolding is required/necessary, it shall be erected on double support tied together by horizontal pieces, over which the scaffolding planks shall be fixed. No part of it shall rest on or touch the surface which is being washed/painted. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls. For white washing the ceiling, proper stage scaffolding shall be erected. The surface on which wash is to be applied shall be thoroughly brushed free from mortar droppings and foreign matter.

11.3.2 White Wash

The wash shall be prepared from fresh stone white lime of approved quality and shall be thoroughly slaked on the spot mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and then shall be screened through a clean coarse cloth. 4 Kg of gum dissolved in hot water shall be added to each cubic metre of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 Kg of lime. Indigo/ultramarine blue upto 3 gm per kg of lime dissolved in water shall then be added and wash stirred well. Water shall then be added at the rate of about 6 litres per kg of lime to produce a milky solution. The white wash shall be applied with approved brushes to the specified number of coats. The operation for each coat shall consist of stroke of brush given from the top downwards, another from the bottom upwards over the first stroke and similarly one stroke horizontally from the right and another from the left before it dries. The white washing on ceiling shall be done prior to that on walls.

Each coat shall be allowed to dry before the next one is applied and shall be subjected to inspection and approval by the Engineer. No portion of the surface shall be left out initially to be patched up later on.

The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed. Doors, windows, floors and such other parts of the building not to be white washed shall be protected from being splashed upon.

11.3.3 Colour Wash

A priming coat of white wash with lime shall be applied before applying two or more coats of the colour wash (as specified). Entire surface should represent a smooth and uniform finish. Sample of colour wash shall be duly approved by the Engineer before application. Same specification as that of white wash shall be followed for colour wash also using necessary amount of colouring ingredient of approved tint.

11.3.4 White Washing with Whiting

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. 2 Kg of gum and 0.4 Kg of copper sulphate dissolved separately in hot
water shall be added for every cum. of slurry which shall then be diluted with water to the consistency of milk so as to make wash ready for use. Other specification remains same as per white washing with lime.

11.4 Cement Primer Coat

The surface shall be thoroughly cleaned of dust, mortar, droppings etc., and shall be allowed to dry for at least 48 hours. It shall then be rubbed thoroughly be sand paper to give a smooth and even surface. 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 undulation and then sand papering the same after it is dry. The cement primer shall preferably be applied by brushing and not by spraying. Horizontal strokes shall be given first and vertical strokes shall be applied immediately, afterwards. This entire operation will constitute one coat. The surface shall be finished as smooth as possible, leaving no brush marks.

11.5 Water-proof cement paint  (DELETED )

Only exterior grade emulsion paints shall be used in this project

The prepared surface shall be thoroughly wetted with clean water before water proof cement paint is applied. The paint shall be prepared strictly as per manufacturer's specifications, in the absence of which it shall be mixed in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. The paint shall be mixed in such quantities as can be used up within an hour of its mixing.

Paint shall be applied with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied as far as possible on the surface which is on the shady side of the building so that direct heat of the sun on the surface is avoided. Painted surfaces shall be sprinkled with water 2 or 3 times a day. This shall be done between coats and for at least 2 days following the final coat. The curing shall be started as soon as paint has hardened so as not to damage by sprinkling of water say about 12 hours after the application. A uniform shade should be obtained after application of paint. Cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper, varnish paint etc., and on gypsum, wood and metal surfaces.

11.6 Synthetic washable distemper(DELETED)

Only plastic emulsion /interior emulsion paints shall be used

The surface shall be prepared as for Cement Primer Coat. A primer coat of cement or distemper primer shall be applied as specified in the description of the item. Unevenness in the plaster shall be made good by applying plaster of Paris putty mixed with distemper of the colour to be used on the entire surface including filling up the undulations. The surface shall then be rubbed down with a fine grade sand paper and made smooth. After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth, taking care not to rub the priming coat out. All loose particles shall be dusted off. One coat of distemper properly diluted with thinner, shall be applied with brushes/rollers in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied to obtain an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats.
The brushes shall be of 15 cm. double bristled type. They shall be maintained in proper condition and those that are dirty or caked will not be allowed to be used. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc. Sufficient quantity of distemper shall be mixed to finish one room for applying one coat in one operation.

11.7 **Dry Distemper (DELETED)**

The surface shall be prepared in the same manner as for synthetic washable distemper. A primer coat using approved whiting shall be applied over the prepared surface. Distemper prepared as per manufacturer’s direction shall be applied and each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be free from chalking when rubbed, even, uniform and shall show no brush marks.

11.8 **Plastic emulsion paint**

The surface on which plastic paint has to be laid must be thoroughly cleaned and prepared and all defects rectified and finally prepared in the same manner as for synthetic washable distemper. The surface shall be dry and rubbed smooth by means of sand paper to the satisfaction of the Engineer. One coat primer and two coats of plastic emulsion paint are to be applied. The work is to be carried out under direct guidance and instructions from the manufacturers whose expert advise and supervision are to be made available in order to achieve the high grade finish. The painters employed for this work must be capable of producing the highest standard of workmanship required. If the finish is of doubtful nature, the contractor shall have to rectify at his own cost to the entire satisfaction of the Engineer.

11.9 **Bitumen painting**

Bitumen painting to concrete surface shall be done as follows:

(i) **Hot application**

The surface shall be cleaned of all mud etc., before painting. The honey-combs and other defects of concrete surfaces to be painted shall be rectified properly. Any projection of binding wire shall be cut to keep it 10 mm inside the concrete surface and then filled with mortar. Before application the surface shall be absolute dry.

Bitumen of standard quality as specified shall be heated to the temperature specified by the maker and then applied hot with brushes on the prepared surface. The surface shall be allowed to cool before applying the second coat.

(ii) **Cold application**

The surface shall be prepared in the same way as for hot application. The bitumen emulsion of approved quality shall be applied with special brushes. Where acid resistant treatment is specified such surface shall be covered with approved acid resisting coating to the satisfaction of the Engineer. Before the coating is applied, the surface shall be properly cleaned and prepared in the manner described above.

11.10 **Tarring**

(i) Timber surfaces in contact with earth/concrete/ plaster shall be treated with one coat of hot tar or as specified in schedule before fixing.

(ii) If required steel work in holdfasts and the like shall be treated as above and sanded in addition before being fixed in position.
11.11 Painting to Timber & Steel Surface

11.11.1 General

The priming coat for steel/wood work shall be applied after the surface has been prepared. After the priming coat has dried, all nails, screw holes and cracks shall be filled with putty and surface smoothened with sand paper.

All surfaces must be thoroughly dry before painting work is started and painting in exterior/exposed parts shall not be taken up in wet/humid or otherwise unfavourable weather.

All stains of paint to glasses, walls, fittings and fixtures etc. shall be cleaned thoroughly by applying required turpentine or thinner. The contractor's rate shall include all these.

11.11.2 Painting to timber

(i) Unless otherwise specified, all timber surfaces shall be treated with one priming coat, one undercoat and one finishing coat. Under coat and finishing coat shall be synthetic enamel or as specified. Priming coat shall be of approved primer. In case the surface is to be polished or varnished, a priming coat as approved or specified shall be given. No primer shall be applied to wood work until it has been inspected and passed by the Engineer.

(ii) Polishing

The surface to be polished shall be prepared in the same manner as specified under painting.

(iii) French Spirit Polish

After preparation of the surface it will be well dusted and then the pores of the wood shall be filled up with a filler made of a paste of whiting in water or methylated spirit with a pigment if so required. The spirit polish shall be prepared by dissolving pure shellac in methylated spirit, @ 0.75 Kg of shellac to 5 litres of spirit, with the addition of pigment if so required.

The polish shall be applied with a pad consisting of cotton wool inside a clean white cloth. Several coats shall be applied with light sand papering from time to time and cleaning the dust before applying next coat except the final coat. The final coat of the polish shall be rubbed thoroughly until the wood feels perfectly dry when touched and gives a satisfactory smooth shining.

(iv) Wax Polishing

After preparation of surface wax polish will be applied. The polish shall be prepared by heating together 2 parts of pure bees wax and boiled linseed oil each over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and one part of genuine turpentine is to be added and entire mixture shall be well stirred.

Polish shall be applied in the same manner as specified for spirit polish.
11.11.3  Painting to Steel Surface

11.11.3.1  General

All surfaces shall be thoroughly cleaned of all dirt, grease, rust and mill scale. Areas which become inaccessible after assembly shall be painted before assembly after cleaning the surfaces as described above. The surfaces shall be perfectly dry before painting.

Wherever shop primer painting is damaged, the surfaces shall be thoroughly cleaned and touched up with corresponding primer.

Site painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surface to be painted.

11.11.3.2  Steel Structures

Unless otherwise specified all structures shall be painted with two coats of primer. One coat shall be applied at shop and the second coat at site. All structures after erection shall be given two coats of finishing paint and shall be of synthetic enamel of approved colour. The under coat shall have different tint to distinguish from the finishing coat.

11.11.3.3  Galvanized Iron Sheets

All plain and CGI sheets requires surface pre-treatment or use of other patented primer to ensure adhesion of paint to zinc coated surfaces. Such pre-treatment shall be as per manufacturer’s specifications. Where pre-treatment is adopted one coat of primer paint of suitable quality shall be applied. Unless otherwise specified the finishing coats shall consist of an under-coat of an aluminium paint having blue tint and a second coat of aluminium paint having aluminium colour.

11.11.3.4  Structures embedded

Exposed surfaces of embedded parts shall be given two coats of red lead graphite primer at shop and finished with two coats of anti-corrosive paint at site after embedment. Type of paint and procedure of painting shall be as per manufacturer’s specification. Surfaces to be field welded shall have no paint applied within 100 mm of the welding zone.

12.0  INTERNAL WATER SUPPLY PLUMBING, DRAINAGE & SANITATION

12.1  Scope of Work

The work comprises supply, laying testing, commissioning etc. of water supply, plumbing, drainage & sanitation.

The work includes the following activities connected with the job:

i) Supply and delivery of all required pipes and other materials.

ii) Earthwork in excavation for trenches, pits/chambers/manholes etc.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the wall etc. and repairing them after pipe erection, construction of pipe
supports, valve chambers, manholes, bedding and covering of pipe laying wherever required.

iv) Laying and jointing of pipe lines as specified in this chapter

v) Testing of pipe lines after laying as per standard tests specified in this chapter.

vi) Back filling of trenches after successful and satisfactory testing.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network.

ix) Safe custody of the pipes/materials/equipment/work and other obligation stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

12.1.1 Materials

The materials shall conform to Part-I of this series.

12.2 Water Supply & Plumbing

12.2.1 General

12.2.1.1 General Requirements

The Contractor shall lay all the pipes and fittings in the best workman like manner by skilled workmen and licensed plumbers in conformity with the regulations and requirements of the local appropriate authorities and to the satisfaction of the Engineer. Unless otherwise specified water supply works in buildings shall be carried out in accordance with IS:2065-1983 “Code of Practice for Water Supply in Buildings” & IS:2064-1993 “Code of practice for selection, installation and maintenance of sanitary appliances”.

12.2.2 Installation

All works like earth work, masonry, concrete, steel work, cutting holes, chases in brick, concrete & RCC works, cutting of roads, repairs and rectifications associated directly with the installation of water supply system shall come under the scope of the contractor and shall be governed by the specification of the relevant chapter.

12.2.3 Laying

Before lowering down for laying in the trenches, the pipes shall be checked against crack by means of light hammering and for any other damage. All fixing shall be carefully aligned and spaced at a distance from the main structure to give reasonable all round access for maintenance and inspection and laid true to line plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface holder or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. If situation requires, pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer. Pipes embedded in floors and
wall shall be securely bound so as not to allow any movement due to expansion and contraction. Adequate width shall be provided to lay the pipes as per standard practice.

Excavation below the required level is not permitted. The contractor shall make good any excess excavation as directed by the Engineer.

Soft spots in the bottom of beds for pipe lines in rock shall be leveled with sand or soft soil or concrete as approved by the Engineer and the thickness of the layer shall not be less than 100mm.

12.2.4 Excavation for pipe lines in trenches

Excavation shall comply with chapter 2. The sides of pits and trenches shall be adequately supported at all times, except where otherwise directed by the Engineer.

12.2.5 Underground piping in and around building

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable, and as shown in the drawing and instructed by the Engineer. The thrust blocks shall be provided wherever required.

The size and depth of the trench shall be as approved by the Engineer. Backfilling in trenches shall be done with selected fine earth, unless otherwise permitted, in 150mm layers and carefully consolidated and well treated so that it does not set as a drainage channel. Special care shall be taken while filling in the vicinity of the pipe to avoid damages. Before backfilling the laid pipe shall be fully tested and approved.

12.2.6 Concealed piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the adjoining structure by making chases in walls/floors and these shall be secured by hooks and the chases filled with concrete 1:2:4 (1 cement, 2 sand and 4 aggregate). The contractor will rectify, if required the chases, openings and pipes, supplement and make good after laying and testing of the concealed pipelines.

12.2.7 GI.Piping (DELETED)

12.2.7.1 The pipes shall be fixed in longest lengths possible with all necessary bends, tees, couplings, reducing sockets, short piece, jamnut and tees etc. in perfect straight lines both vertically and horizontally.

12.2.7.2 All exposed GI pipes shall be fixed at least 15mm clear of wall face with holder bat clamps at suitable places not exceeding (2.5 metres) centre to centre. Where the pipes are laid in chases in walls as shown in the drawing, these shall be secured to walls by hooks. Chases in walls and floors shall be filled in with cement concrete 1:2:4. Where the pipes are to be run underground these may be laid at least 60 cm below ground level.

12.2.7.3 The joints of pipes and fittings shall be sealed with red lead paint and fine spun yarn. Joints must be perfectly water tight when put under maximum test pressure.

12.2.7.4 Unless otherwise specified the exposed portion of pipes and fittings shall be given two coats of approved synthetic enamel paint over a coat of approved priming. Pipes laid underground or concealed in walls/floors shall be treated with two coats of bituminous paint.

12.2.8 Jointing of pipes
The interior of all pipes and joints shall be cleaned before jointing commences. Jointing of pipes shall be done in such a manner as to render them completely leak proof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, the general norms and recommended practices for different types of pipes are given below for guidance:

(a) Cast Iron

i) Spigot and socket joints:

Interior surface of bells and exterior surface of smooth ends of pipes shall be cleared of redundant insulating cover and other foreign materials particularly of oil, burning off materials from bells and smooth pipe ends. Sharp rises on interior bell surface shall be smoothed out.

Bells should be lined up, in compliance with direction of pipe. Laying work shall be started from lower points.

ii) Lead and Flanged Joint:

Lead joint shall be made as per Sl. 15.4.6.1 and flanged joints as per Sl. 15.4.6.2 of chapter 15.

(b) Steel Pipes

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove burring from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer.

c) GI Pipes

Threads shall be cut with, sharp tools, and before jointing all scale shall be removed from pipes by suitable means. The screw threads of the pipe shall be cleaned out and the joint made by screwing the fitting after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) Asbestos cement pipes

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

12.2.9 Precautions

a) All water supply pipes shall be so laid and so fixed and maintained as to be and remain completely water tight.

b) During installation open ends of each pipe shall be protected by suitable covers or plugs so that the ends, thread, sockets or spigot are not damaged and no foreign materials can make its way into the pipe line.

c) Due care should be taken to ensure that there shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting containing impure water or water liable to contamination or of an uncertain quality of water which has been used for any other purposes.
d) Fittings and fixtures liable to be stolen shall be fitted and fixed just before testing and handing over.

12.2.10 Painting

When mentioned in the schedule of item underground steel and cast iron pipes shall be treated with 2 coats of anticorrosive bituminous paint on the outside surface after cleaning the surface from soil, dust, moisture, rust, scales soot etc. When painting is to be done for pipes above ground, G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer over which at least 2 coats of paint of best quality and manufacture as approved by the Engineer shall be provided or as specified in the schedule of item.

12.2.11 Ferrule and stop cock box with chamber

Square cast iron surface box 15 cm square and 22.5 cm deep weighing not less than 4.54 Kg with hinged lid shall be provided in masonry chamber. Top of box shall be made flush with the finished level of the chamber. The chamber 25cm x 25cm inside shall be with half brick wall in cement mortar 1:4 over a cement bed concrete of 75mm thick in proportion 1:4:8 with stone chips. The inside wall faces shall be plastered with 12mm thick cement mortar 1:4 finished smooth with a floating coat of neat cement.

The exposed surfaces of cast iron box and cover shall be treated with two coats of bituminous paint.

12.2.12 Inspection, Testing and Acceptance

12.2.12.1 Pipes, fittings and fixtures before laying

All pipes, fittings and appliances shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

12.2.12.2 Testing of pipes after laying

General

a) The contractor shall ensure the safety of the pipe work under test and provide all necessary stoppers, testing apparatus etc. that are required for testing.

b) The contractor shall be responsible for any damage done to pipe work and ancillary work while testing and shall replace any pipe or fitting which does not satisfactorily withstand the test.

c) The contractor shall give written notice of the times at which tests are to take place. On completion of each test two copies of the complete records shall be given to the Engineer.

d) The work will not be considered complete until the tests are found satisfactory and a certificate issued by the Engineer.
After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits and then tested under pressure. The test pressure shall be 6Kg/cm² or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or a large diameter, by a power driven test pump, provided that pump is not left unattended. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been re-calibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

12.2.12.3 Testing of service pipes and fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All pipings, fittings and appliance shall be checked for satisfactory support and protection from damage, corrosion and frost.

12.2.13 Storage Tank

12.2.13.1 Pressed steel tank

Pressed steel water storage tanks shall be of nominal size and capacity as mentioned in the Schedule of Item and fabricated with all flanges external / internal or bottom flange internal and side flanges external, as shown on drawings or schedule of items. Inlet, overflow, vent pipes and manholes shall be arranged and provided as shown in drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50mm above the bottom of the tank and there shall be 150mm free board at the top of the tank. The fabricator shall supply 5 prints of fabrication drawing to the Engineer for prior approval showing thickness of plates, method of jointing the plates. All supports, stays, gussets etc., required for supporting the tanks shall also be supplied by the manufacturer.

All tanks shall be supplied with mosquito-proof top with manhole not less than 450mm diameter. Tanks deeper than 1.00 Metre shall be provided with M.S. internal access ladder adjacent to the manhole. Meter level indicator shall be provided if asked for. Two coats of anticorrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. The paint shall be so selected as not to impart any taste or odour of water and be of lead free composition.

12.2.13.2 G.I. Water Tank

G.I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanized iron water storage tank shall be made of minimum 16 gauge galvanized iron sheet. Unless otherwise specified plain sheets shall be fixed at the corner to angle iron frames by means of 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised iron stays, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. Lead shall be applied to the joints before rivetting.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but...
close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks unless otherwise specified shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on drawing and 40 mm dia. G.I. overflow pipe and 25 mm washout with plug. If specified the rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve shall permit the entry of water when the tank is empty and disconnect the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hard rubber, 110 mm in diameter attached to an arm which is so pivoted that the end near the pivot close the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution. The ball valve shall be fixed to the tank in such a position that the body of the ball valve submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water in the tank below the lip of the over-flow pipe, and above the maximum water filled level shall be as per the standard norms for GI water tank.

12.2.13.3 Water reservoirs made of concrete or masonry shall be governed by the specification in the relevant chapter. It shall have, inlet, outlet, overflow and wash out with plug and a top MS/CI cover as per schedule of items and drawings.

12.3 Drainage and Sanitation (Internal)

12.3.1 Scope

This section covers the layout and construction of drains for waste water, surface water and sewage together with all fittings and fixtures inclusive of ancillary works, such as connectins, manholes and inspection chambers used within and around the building and the connection to a public sewer upto treatment work, septic tank and soak pit. All sewerage and drainage works shall be executed in accordance with specifications given for different works. All sewerage and drainage works shall be executed by a licensed plumbing supervisor or a licensed plumber and in accordance with IS : 1742-1983 "Code of Practice for Building Drainage" unless otherwise specified.

12.3.1.1 Installation

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumbs, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and shall be located so as to allow easy maintenance.

All pipelines, fittings and fixtures shall be installed leakproof; when the works under scope of this specification are linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gasses.

12.3.2 Rainwater Downcomers

Rainwater downcomers shall be High density PVC pipes shall be used in this project. Cast iron pipes shall not be used. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paint over a coat of primer. Rain water downcomers shall run along and be secured to walls columns, etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clamp type, split ring type or perforated strap iron type.
as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed. Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings. All horizontal pipes shall have a minimum fall of 1 in 100.

12.3.3 Gutter

The gutters shall be made of G.I. or A.C. Gutters shall be supplied by reputed specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. GI gutters shall have the edges strengthened by suitable means. The joints may be made by rivetting, bolting or soldering.

Unless specified otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no deflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated of MS brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater downcomers shall be made fully watertight and secured.

12.3.4 Soil and Drainage Pipes

12.3.4.1 Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows:

100 mm nominal dia : 1 in 35
150 mm nominal dia : 1 in 65
230 mm nominal dia : 1 in 120
300 mm nominal dia : 1 in 200

12.3.4.2 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and soil pipes be allowed to come close to water supply pipelines.

12.3.4.3 Laying

Each separate pipe shall be individually set for lines and levels. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 16 m apart. The excavation shall be boned in at least one in every 2 m. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

12.3.4.4 Support and protection on pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's
instruction as approved by the Engineer shall be followed in the matter of support and jointings.

Where pipes are not bedded on concrete, the bed shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of sand or gravel as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 1 metre and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased surrounded with concrete as per IS:4127-1983.

b) Where pipes are laid on soft soil with the maximum water table lying at the invert of the pipes, the sewer shall be bedded on concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched with concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

d) Where maximum water table is likely to rise above the top of the barrel the pipe sewers shall be completely encased/surrounded with 1:4:8 concrete with 20mm down aggregate as per IS:4127-1983.

Vitrified clay pipes shall be laid on a bed of 150mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The support shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

12.3.4.5 Entry into structures

For entry of the pipes lines into any building or structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. Where openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline, the openings and chases shall be mended.

12.3.4.6 Traps and Ventilating pipes

a) Pipes carrying the sewage from water closets and waste water and overflow water from baths, wash basins, sinks shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600mm above the outer covering of the roof top of the building or as shown on
drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

Connecting to existing sewer lines shall be through a manhole.

b) **Sand Cast Iron Spigot and Socket pipe and fittings**

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS:1729-1979. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior of the pipes and fittings shall be clean and smooth and painted inside and outside with Dr. Angus Smith's solution or other approved anticorrosive paint. Fittings shall include bends, offsets, branches of various types, junctions etc. as required for the work which shall be provided according to drawings and directions of the engineer.

The fittings shall be provided with access doors where so specified or directed by the engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3mm thick rubber insertion packing, and when closed and bolted they shall be watertight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

**Fixing**

The pipes and fittings shall be fixed to wall by means of MS holder bats clamp of approved type and steel bolts or by pipe nails, bobbins etc. as the case may be, keeping the pipe clear from the finished surface of the wall. The holder bat nails shall be fixed to the wall in wooden block. The soil pipe shall be supported at the foot upon a bed of cement concrete of proportion 1:3:6 and firmly attached to the wall.

The pipes shall be laid truly vertically or along the line as shown in the drawing. Connection between main pipe and branch pipe shall be made by using branches and bends with access door for cleaning.

All vertical soil waste, ventilating and anti-siphonage pipes shall be carried up above the roof and provided with suitable C.I. cowl on top.

Pipes outside the building shall be laid underground for which trenches shall be excavated as required for the work. The trenches shall be back-filled with excavated material after the drainage system has been tested and passed.

**Jointing (Lead Caulked Joint)**

Unless otherwise specified, the pipes and fittings shall be jointed with lead joints as described below:

The annular space between the socket and spigot will be first well packed in with tarred gasket or hemp yarn leaving 25mm from the lip of the socket for the lead. The joint may be leaded by using proper leading rings or if they are not available by wrapping a ring of hemp rope covered with clay round the pipe at the end of the socket, leaving a hole through which lead shall be poured in (for pipes with sockets facing a upwards 15mm high small clay band on socket edge may be used).

The lead shall be rendered thoroughly fluid and each joint filled in one pouring. Before caulking, the projecting lead shall be removed by flat chisels and then the joint caulked round with proper caulking tools and a hammer of 2 to 3 pounds in weight in such
manner as to make the joint quite sound. After being well set up the joint is to be left flush neat and even with the socket.

Lead for caulkimg shall conform to IS: 782-1978.

Painting

All the exposed CI pipes and fittings shall be painted to match the colour of the surroundings. The surface of the pipes and fittings to be painted shall be cleaned thoroughly and painted 2 coats with approved paint over and including 1 coat of approved primer. Pipes laid underground shall be painted with 2 coats of anti-corrosive paint.

12.3.4.7 Cutting of pipes

Manufacturer’s instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

12.3.4.8 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and man- holes shall be gas tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

(a) Sand Cast Iron Pipes

Jointing of cast iron pipe shall be done as described in Sl. No. 12.3.4.7(b).

(b) Concrete pipes

i) Spigot & Socket Joint

The opening of the joint shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) which shall be rammed with caulkimg tool.

ii) Collar Joint

Joint shall be done by slipping the collar over and clear of the end of the pipe. The recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen. Care shall be taken that no off-set of the jute braiding shall be visible either outside or inside the pipe. The collar shall be then set up over the joint covering equally both the pipes and leaving an even caulking space all round. cement and sand mortar (1:1.5) shall then be well punched or pressed home with a caulking tool.

(c) Glazed stoneware pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed 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 the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the socket. The reminder of the socket shall be filled with a stiff mixture of
cement mortar of 1:1 proportion. When the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 degree with the barrel of the pipe. The newly made joints shall be protected, until set, from sun and rain and shall be covered with damp sacking or other suitable materials.

12.3.5 Trenches and other excavations

Excavation shall be carried out according to chapter-2, Earthwork.

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench. The spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work. Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement. All excavations shall be properly timbered, where necessary. Efficient arrangements for dewatering during excavation and keeping it dry till back filling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the contractor from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken for packing with selected material in areas 300 mm around the pipe. At least 300 mm over the pipe shall also be filled with soft earth or sand.

Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All settlements shall be made good regularly to minimise inconvenience or traffic where applicable.

12.3.6 Installation of fittings & fixtures

12.3.6.1 General

All fittings & fixtures shall be laid out as per drawings and in proper line, level and shall be firmly secured to floors with screws and ditto fix and to walls with wall plugs and screws. Unless otherwise specified only C.P. Brass screws shall be used for fixing sanitary fittings to wall plugs and floors.

12.3.6.2 European pattern WC

Water closet shall be fixed with floor by means of 75 mm long, 6.5 mm diameter counter sunk bolts & nuts embedded in floor using rubber or fibre washers so as not to allow any lateral displacement.

12.3.6.3 Indian Pattern W.C.

The water closet pan shall be sunk into the floor and embedded in a cushion of average 150 mm cement concrete 1:4:8 (1 cement, 4 sand and 8 broken brick ballast of 40 mm size). The concrete shall be left about 125 mm below the top level of the pan so as to
allow for flooring and its bed concrete. The joint between the pan and trap shall be made with C.M. 1:1 and joint between trap and CI soil and waste pipe to be made with lead. All the joints shall be leak proof. The WC floor shall slope towards the pan. The foot rest shall be set in cement mortar 1:3 (1 cement : 3 sand).

The cast iron cistern, brackets and flush pipe etc. shall be painted with two coats of approved paint, over and including a coat of approved priming.

12.3.6.4 Wash basin

Wash basin shall be fixed to C.I./R.S. brackets fixed in cement mortar 1:3 (1 cement :3 sand). The brackets shall be fixed to approved wooden wall plugs with screws. C.P. brass trap and union shall be connected to waste pipe if specified.

12.3.6.5 Urinals

The urinal shall be fixed to the walls with C.P. Brass screws fixed to wooden wall plugs. Urinal partitions shall be fixed to walls by making chases in walls and grouting the same in 1:2:4 cement concrete.

12.3.6.6 Mirror

Fixed type mirror shall be screwed to wall plugs with CP brass screws and shall have a backing of asbestos or similar material as specification in the item.

Swivel type mirror shall be fixed with C.P. brackets which shall be fixed to wall plugs with CP brass screws.

12.3.6.7 Soap tray / toilet paper holder

This shall be of flush mounting design and shall be housed in walls by making chases and grouting the same in cement mortar 1:3 unless otherwise specified. All other fittings shall be fixed with screw or as per manufacturer's specification.

12.3.6.8 Towel rail & Toilet glass-shelf unit

This shall be fixed with CP Brass screws which shall be fixed to wall plugs.

12.3.6.9 Gully trap

This shall be fixed on 100 mm thick bed and encasement of size 600mm x 600mm x full height of trap shall be provided with cement concrete of proportion 1:4:8 with 40mm stone aggregate. The gully outlet shall be jointed to the branch drain as specified or directed by the Engineer.

12.3.6.10 Masonry chamber for Gully Trap

After fixing and testing gully and branch drain, a brick masonry chamber 300mm x 300mm x 450mm deep or as specified (internal dimensions) in cement mortar 1:4 (1 cement and 4 sand) shall be built with half brick thick wall round the gully trap from the top of the concrete. The internal faces of the chamber shall be finished smooth with 15 mm thick cement plaster (1:4) and neat cement finish. Brick wall exposed to outside shall be finished with 12 mm thick cement plaster 1:4. P.C.C. (1:2:4) band 100 mm thick shall be provided over the brick work with suitable grooves for accommodating R.C.C. cover to be supplied as per drawing and made water tight by providing suitable beading in the band.
12.3.6.11  High level flushing cistern - (fixing flush pipe & cistern)

The W.C. pan shall be connected to the cistern by G.I. 32mm dia or 40mm (O.D) high density polythene flush pipe with holder clamp and brass coupling.

12.3.6.12  Low level flushing cistern

Unless otherwise specified, it shall be connected to the closet by means of 40mm dia white porcelain enameled flush bend using rubber adaptor joints.

12.3.7  Septic tank and effluent disposal

12.3.7.1  Septic tank

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawing. This item shall also include ventilating pipe of at least 100mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Generally ventilating pipe shall extend to a height of about 2 metres when the septic tank is at least 15 metres away from the nearest building and to a height of 2 metres above the top of building when it is located closer than 15 metres. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

12.3.7.2  Effluent disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed S.W pipes laid in a trench filled with broken bricks.

12.3.7.3  Soak Pit

Shall be complete as shown on drawing. In absence of a detailed drawing it shall consist of a 900mm dia pit 1000mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks with dry open joints backed with at least 75 mm of clean coarse aggregate. The lining above the inlet level shall be set in cement mortar (1:6). The pit shall be filled with brick bats. Inlet pipe shall be taken down to a depth of 900mm from the top as an anti-mosquito measure.

12.3.7.4  Open jointed S.W pipes

Minimum dia of the S.W pipes shall be 200mm nominal. The trench for laying the pipes shall be minimum 600x600mm. The joints of the pipes shall be left unsealed.

12.3.7.5  Commissioning septic tank

After the septic tank has been proved water-tight and the sewage system is checked, the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow dung may be introduced.
12.3.8 Manhole/Inspection chambers

Necessary excavation as required for the manhole shall be done true to dimensions and levels as shown in the drawing. The manhole chamber shall be built with brick work in C.M. 1:4 with minimum one brick thick on a base of 100mm thick cement concrete 1:4:8 with 40mm down aggregate or as specified. The concrete bed shall extend beyond the external face of brick work on all sides by at least 75mm. The thickness of wall shall be as indicated. The work shall be carefully built in English bond, the jointing faces of each brick being wall buttered with cement mortar before laying so as to ensure a full joint.

The inside of the walls shall be plastered with 15mm thick cement mortar 1:4 and finished with a floating coat of neat cement and outside shall be plastered with 12mm thick C.M. 1:4.

The channels and benching shall be done in cement concrete 1:2:4 with 20mm down stone aggregate and finished with 12mm thick cement plaster in C.M. 1:3. The channels shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter the top edge shall be suitably rounded off. The Branch channels shall also be similarly constructed with respect to benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow of the main channel shall be given. The benching at the sides shall be carried up in a slope of 1 in 3.

All angles shall be rounded to 75mm radius with cement mortar 1:4 and shall be rendered smooth. The internal surfaces shall have a hard impervious finish obtained by using a steel trowel.

The manhole chamber shall be covered on top with RCC (1:2:4) slab with necessary reinforcement as per drawings. Unless otherwise specified circular type light duty M.H. cover with single seal weighting 25 kg. will be provided in each RCC cover.

12.3.9 Testing and acceptance

12.3.9.1 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

12.3.9.2 Testing of pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual test shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

12.3.9.3 Smoke Test

Soil, waste, vent and all other pipes, when above ground, shall be tested for gas tightness by a smoke test conducted under a pressure of 25mm water gauge and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.
12.3.9.4 Water Test

For pipes other than cast iron Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the end of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in funnel which could be raised or lowered till required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following causes:

a) Absorption by pipes and joints.
b) Sweating of pipes or joints
c) Leakage at joints or from defective pipes
d) Trapped air

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut and made good.

12.3.9.5 For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

12.3.9.5.1 For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end and;

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

12.3.9.6 Testing septic tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15mm.

12.3.9.7 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.
13.0 EXTERNAL SEWERAGE & DRAINAGE

13.1 Scope of Work

The work comprises supply, laying, testing, commissioning etc., of sewerage & drainage network as specified.

The work includes the following activities connected with the job.

i) Supply and delivery of all required pipes and other materials including erection.

ii) Earth work in excavation for trenches and pits/ manholes.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the walls etc., and repairing them after pipe erection, construction of pipe supports, brick / concrete manholes, preparation of concrete bedding and covering for pipe laying wherever required etc.

iv) Laying and jointing of the pipelines as specified in this chapter

v) Testing of the pipelines after laying as per standard tests as specified in this chapter.

vi) Back filling of the trenches after successful and satisfactory completion of tests for the pipeline laid.

vii) Cleaning, painting/coating and wrapping etc of pipes and fittings etc.

viii) Commissioning of entire network laid.

ix) Safe custody of pipes/material/equipment/work and other obligations stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

xi) If specified, at road crossing the pipe shall be laid in encasing pipes, wrapped & coated M.S pipes shall be used as encasing pipes. The encasing pipe shall project beyond the berm or both sides of the road. The encasing pipe shall be supported on P.C.C saddles if the site condition warrants so.

13.2 Materials

The materials shall conform to part-I of this series. Sewerage net work in Township shall generally be of R.C.C/S.W.G pipes, R.C.C pipes being used normally for pipe sizes of 400mm dia and above. In plant area, at road crossings etc Cast Iron Pipes may be used.

13.3 Excavation of trenches & pits

Excavation shall be carried out according to Chapter of Earthwork.

Before starting earth work in excavation, temporary drainage arrangement shall be provided to prevent surface water entering the trenches and pits at the cost of Contractor.

Excavation of trenches and pits for pipelines shall be carried out in shortest possible time so as to avoid sinking of ground and consequent damage to the pipelines.
Excavation of trenches for pipelines and surface drains, shall be in exact accordance with the plans and section, alignment, levels and gradients as indicated on the drawings or as directed at site by the Engineer. The final bed must be dressed, levelled or trimmed to proper gradient and rammed with sprinkling of sand and got passed by the Engineer. No excavation shall be made below the specified levels without written permission of the Engineer. Should any excavation be taken below the specified level due to carelessness of the Contractor, he will fill in such excavation at his own expense as specified in clause 2.12.

13.4        Cast Iron Pipes

I.S. 3114-1985 has to be followed in general for laying and jointing of pipes unless otherwise specified.

13.4.1        Back filling

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top.

ZONE."A"    From the bottom of the trenches to the level of the center line of the pipe.
ZONE."B"    From the level of the center line of the pipe to a level 300 mm above the top of the pipe.
ZONE."C"    From a level 300 mm above the top to the top of the trench.

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer but back filling shall be done, at least from the bottom of the trench to the level of the center line of the pipe (ZONE "A") leaving 450 mm on either side of the joints uncovered, with earth till testing is completed. These joints should however be kept covered with mats, gunny, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage should be done to the pipeline. All back fill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetables or organic material, lumpy or foreign material, boulders, rocks or stones or other materials which in the opinion of the Engineer is unsuitable or deleterious. However, materials containing stones up to 20 cm as the greatest dimension may be used in Zone "C" unless specified otherwise herein.

Backfilling in Zone."A" shall be done by hand with sand, fine gravel or other approved material placed in layers of 80 mm and compacted by tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fitting and appurtenances simultaneously.

Backfilling in Zone."B" shall be done by hand or approved mechanical methods. Special care being taken to avoid injuring or moving the pipes. The type of back fill materials to be used and the method of placing and consolidating shall be prescribed by the Engineer to suit individual locations.

Back filling in Zone."C" shall be done by hand or approved mechanical methods. The type of back fill materials and method of filling shall be as prescribed by the Engineer.

Paving and metaling shall be reinstated in as good order as before removal and the Contractor shall do adequate ramming and watering of under layers to guard against subsequent settlement all at his cost.
13.4.2 Custody of pipes

The Contractor shall remain responsible for the safe custody of pipes, specials and other materials supplied by him/issued to him either free or on cost recoverable basis till these are laid installed, tested, back filled etc., and handed over to the Engineer.

The Contractor shall verify the conditions of the pipes, specials etc., at the time of receipt from sources and shall be responsible for all damages during handling, transporting, laying, installing, testing etc., and the cost of such damages shall be borne by the Contractor.

13.4.3 Erection/laying of pipelines

i) Erection of all equipment shall be carried out with highly skilled workers.

ii) The pipelines shall be laid and supported properly and it shall be deemed as a contractual obligation that the lines are not thrown out of alignment or lifted off during commissioning and subsequent operation.

13.4.4 Pipeline erection

All the underground pipelines shall be laid in accordance with IS : 3114-1985.

13.4.5 Handling of pipes & fittings

Unloading of pipes & fittings

While unloading, pipes shall not be dropped down from trucks on hard surface. This should be done with the help of a steadying rope and timber skids. Pipes should not be dragged, specially to the spigot end along hard surface.

Lowering of pipes & fittings

Proper implements, tools etc. shall be provided and used by the contractor while lowering pipes & fittings in the trenches and in no case these should be dropped. Pipes over 300mm dia shall be handled with the help of chain pulley blocks with tripod supports.

Detection of cracks in pipes and fittings

The pipes and fittings shall be inspected for defects and cracks by ringing with a light hammer preferably while suspended. Smearing the outside with chalk dust helps location of the crack. If doubt persists, pouring a little Kerosene on the inside of the pipe at the suspected spot will confirm it as it will seep through.

Cleaning of pipes and fittings

All foreign materials shall be cleaned from the socket and spigot ends both from inside and outside. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being laid. When pipe laying is not in progress, the open ends of the pipe shall be closed suitably.

Cutting of pipe

The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat manner without damage to the pipe. Pipe cutting machine may be used for this purpose and in case it is not available, for large diameter pipes electric arc cutting method using a...
carbon or steel rod may be adopted. The pipes can be cut by using chisels also depending on the circumstances.

**Permissible deflection at socket and spigot joints**

**Direction**

On level ground the socket ends should face the upstream. When the line runs uphill the socket ends should face the upgrade.

**Permissible deflection**

In case it becomes necessary to deflect pipe from a straight either in the vertical or horizontal plane, due to obstructions or where long radius curve is permitted, the following norms shall be adhered to:

- Lead joint 2.5 degrees
- Rubber joints for nominal bore 80 to 300mm: 5 degrees
- Rubber joints for nominal bore 350 to 400mm: 4 degrees
- Rubber joints for nominal bore 450 to 750mm: 3 degrees

**Anchor and thrust blocks**

Suitable concrete thrust blocks shall be installed, wherever the thrust is appreciable, specially at dead ends and bends. In case of unbalanced also this may be required. In case of steep gradients and under influence of temperature change also thrust blocks may be required for rigidly joined pipes.

It is advisable to avoid sharp bends above 45 degrees. In soft ground as far as possible two bends should not be put together and be separated by at least one length of straight pipe.

Anchor or thrust blocks shall be generally as per IS: 5330-1984 and thrust resistant design pressure shall be equal to the test pressure.

**13.4.6 Pipe jointing**

The type of jointing will be defined in the detailed working drawing and Schedule of items i.e. whether they should be (i) socket and spigot with molten lead or lead wool joint or (ii) flanged joint.

**13.4.6.1 Socket & spigot joints**

- **a) Molten lead joints**

  Unless otherwise specified, socket and spigot joints shall be done with molten lead.

  The spigot shall be cleaned of the coating, carefully entered in the socket of the adjacent pipe by one or more laps of white hampen spun yarn, sufficient yarn only being driven into the socket to leave the depth of the lead specified. The proper depth of each joint shall be tested before running the lead by passing completely round it a wooden gauge, notched out to the correct depth of lead, the notch being held close up against the face of the socket. The pipes shall be carefully packed underneath so that they shall bear properly throughout their whole length.
The lead shall be carefully skinned of all scale when melted in a cast iron pot or patent melting machine. The joints must be perfectly dug before being run with lead. The pipes shall again be examined for line and level and the space left in the socket shall be filled in generally by pouring in melted lead. This may be done best by using proper loading rings or if these are not available, by wrapping a ring or hemp rope, covered with clay round the pipe at the end of the sockets leaving a hole into which lead shall be poured. For large pipes, it is also necessary to leave one or more air vents around lower half of the joints. The lead shall be rendered thoroughly fluid and each joint shall be filled at one pouring. If the pipe is too large for the joint to be filled from one ladle, two or more ladles shall be used. It is to be noted that the lead should be heated to such a temperature as will ensure that it flows completely around the joint. Overheating of lead shall be avoided.

After a section of convenient length has been laid, lead caulking shall be commenced. The lead shall be freed from the loading pipe outside the socket of the other pipe with a flat chisel, and then caulked around 3 separate times, with proper caulking tools of increasing thickness and a hammer 2 to 3 kg in weight in such a manner as to make the joints sound and water tight. After being well and evenly set, the joint is to be left flush neat and even with the socket. The approximate weight of lead and spun yarn for different size of cast iron pipe socket and spigot joints, as per IS : 3114-1985 are given in the Table-I.

### TABLE – I

<table>
<thead>
<tr>
<th>Nominal of pipe mm</th>
<th>Lead / Joint kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.8</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
</tr>
<tr>
<td>200</td>
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<td>250</td>
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<tr>
<td>300</td>
<td>7.2</td>
</tr>
<tr>
<td>350</td>
<td>8.4</td>
</tr>
<tr>
<td>400</td>
<td>9.5</td>
</tr>
<tr>
<td>450</td>
<td>14.0</td>
</tr>
<tr>
<td>500</td>
<td>15.0</td>
</tr>
<tr>
<td>600</td>
<td>19.0</td>
</tr>
<tr>
<td>700</td>
<td>22.0</td>
</tr>
<tr>
<td>750</td>
<td>25.0</td>
</tr>
</tbody>
</table>
Note:
The quantities of lead given are provisional and a variation of 20% is permissible either way.

b) Lead wool joint

In the event of the Engineer specifying or permitting the use of lead wool the joint shall be made as follows:

Hempen spun yarn shall be driven into the socket and thoroughly caulked with suitable caulking tools. Lead wool shall then be introduced and this caulking shall be repeated with each turn of lead wool under which the socket is full within 3 mm and the wool of the lead wool is compressed into dense mass. The joint shall then be finally pressed with finishing tool. The table giving the quantity of lead wool and yarn to be used in different sizes of pipes is given in the Table-2

<table>
<thead>
<tr>
<th>Nominal Internal dia in mm</th>
<th>Lead wool weight in kg</th>
<th>Spun yarn weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.30</td>
<td>0.17</td>
</tr>
<tr>
<td>100</td>
<td>1.70</td>
<td>0.23</td>
</tr>
<tr>
<td>150</td>
<td>2.41</td>
<td>0.34</td>
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<td>175</td>
<td>2.89</td>
<td>0.37</td>
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<td>200</td>
<td>3.37</td>
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<tr>
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<td>4.82</td>
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<td>350</td>
<td>6.04</td>
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<tr>
<td>375</td>
<td>6.52</td>
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</tr>
<tr>
<td>600</td>
<td>12.79</td>
<td>2.83</td>
</tr>
<tr>
<td>750</td>
<td>15.68</td>
<td>3.52</td>
</tr>
<tr>
<td>825</td>
<td>17.12</td>
<td>3.88</td>
</tr>
</tbody>
</table>
13.4.6.2 Flanged joints

Flanged joints should be made by painting the facing of the flanged with graphite or red lead freely. Packing should be of rubber insertion sheet or compressed fibre board and of approved thickness. The packing should be of full diameter of the flange with proper pipe hole and bolt holes cut out and even at both the inner and outer edges. All the bolts shall be tightened up evenly on all sides keeping the longitudinal axes of adjoining pipe in exactly the same straight line.

The interior of the pipe must be checked carefully so as to be free from all dust and other foreign matters as the work proceeds. For this purpose a disc plate or brush sufficiently long to pass two or more joints from the end of the pipe last laid shall be continuously drawn forward as the pipes are laid. The ends of the pipes must be securely protected preferably with wooden plugs during the process of the work. The pipes laid must not be made receptacles either for tools, cloth or any other material during progress of the work.

13.4.7 Inspection & testing

a) If required all materials shall be inspected by the Engineer before dispatch to site. All the tests shall be carried out in the manufacturer's works and necessary test certificates shall be furnished as proof of such testing. The Contractor shall intimate the Engineer at least two weeks in advance for any such inspection / testing. All facilities for inspection / testing including necessary test certificates shall be provided by the Contractor at his own cost.

b) After completion of erection all pipelines shall be inspected by the representative of the Contractor and the Engineer. Any discrepancy, defect pointed out during this inspection shall be made good by the Contractor to the entire satisfaction of the Engineer without additional cost.

c) All pipes with valve and fittings shall be tested to 1.5 times maximum working pressure. The pressure should remain constant for a period of 8 hours. All arrangements for testing shall be done by the Contractor. Any defect found during testing shall be made good by the Contractor to the entire satisfaction of Engineer and the test shall be repeated till acceptable results are achieved. Any special tools, instrument or equipment required for these tests shall be provided by the Contractor for tests only.

d) All oils, lubricants and other consumables required during tests and trials of different equipment shall be supplied and arranged by the Contractor at his own cost.

<table>
<thead>
<tr>
<th>Nominal Internal dia in mm</th>
<th>Lead wool weight in kg</th>
<th>Spun yarn weight in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>900</td>
<td>18.80</td>
<td>4.25</td>
</tr>
<tr>
<td>1200</td>
<td>28.44</td>
<td>6.01</td>
</tr>
</tbody>
</table>

Note: Higher tolerance may be permitted under special circumstances depending upon site condition for quality of lead wool and spun yarn.
13.4.8 Painting

i) All equipment, valves and other exposed steel parts shall be given a coat of red oxide, zinc chromate or red lead and two coats of final approved quality paint according to the colour scheme of the Purchaser.

ii) All the exposed pipes and fittings shall be painted with two coats of paints of approved quality.

13.4.9 Commissioning

After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and foreign materials.

The system shall be commissioned after all necessary tests have been conducted successfully. All lubricants, oils, and other consumables required for commissioning of the system shall be supplied by the Contractor at no extra cost. Commissioning of the equipment to be supplied, if any, by the Owner, shall be carried out by the Contractor under guidance of the representatives of the supplier of these equipment and Engineer. Any adjustment and/or changes/rectifications that may be found necessary during commissioning of these equipment shall be carried out by the Contractor at his cost.

13.5. Stoneware Glazed Pipelines (S.W.G)

13.5.1 Back filling

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer, but back filling shall be done at least for a depth equal to the diameter of the pipe or 300 mm whichever is greater over the pipes leaving 450 mm on either side of the joints uncovered with earth till the testing is completed. These joints should however be kept covered with mats, gunny bags, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage is done to the pipelines. The first 300 mm of filling material immediately over and around the pipe should be of soft material free from clods and stones etc. The remainder of the filling materials shall be watered and rammed in layers not exceeding 250 mm at a time.

Paving and metalling shall be reinstated in as good order as before laying of the pipelines.

Unless otherwise required by the Engineer, there shall be a minimum cover of 700 mm over the pipes and at road crossing etc., it shall not be less than 900 mm.

13.5.2 Laying of pipes

The laying of the pipelines shall commence only after the levels of the bottom of the trench at various points have been checked by the Engineer. Cracked pipes whether at the socket or in the body shall be rejected. All SW pipes shall be fitted together on the surface of the ground to ensure a proper fit before they are lowered. The spigots and sockets shall be properly cleaned and brushed, if necessary & then lowered by hand to the bottom of the trench.

The pipes shall be carefully laid to the alignment, levels and gradients shown on the plans and sections, and great care shall be taken to prevent, sand, earth or other matter from entering the pipes during laying. As it is not permitted to rectify errors of grade by packing up underneath with earth, care should be taken in excavating and slight
scraping, if necessary, done to bring to grade. The pipes between manholes shall be laid truly in straight lines without vertical or horizontal undulations.

Bedding, haunching or encasing of the pipes during laying shall be in accordance with IS : 4127-1983 and shall be done with cement concrete in proportion (1:4:8) to prevent ground water from entering the pipelines.

All inverts shall be laid from site rail fixed at the true levels, with proper boning rod. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor at his own expense.

The pipes shall be laid, sockets facing up the gradient, beginning at the lower end, and with the sockets, resting in the socket rest holes cut in the trench bottom. Each pipe shall be laid singly and no pipe shall be laid until the trench has been excavated to its required depth to a distance of twenty yards in front of the pipes to be laid.

No pipes of any description shall be covered until they have been passed by the Engineer.

13.5.3 Jointing of pipes

(a) Cement joint

The stoneware pipes shall be cement jointed normally. In case, if specified so, bituminous joints shall be used. In each joint, spun yarn soaked in neat cement slurry or gasket of tarred yarn shall be passed round the joint and inserted in it by means of suitable jointing tools. More skeins of spun yarn or gasket shall then be added and well rammed home. The yarn shall be moistened to avoid absorbing moisture from cement mortar.

The yarn should be so placed as to centre the spigot of one pipe within the socket of the other and shall prevent the jointing mortar penetrating inside the pipe where it might set and interfere with the flow of sewage.

Yarn or gasket (cemented or tarred) so rammed shall not occupy more than one-fourth of the depth of socket.

The cement shall be thoroughly mixed with medium sand in the proportion of 1:1 (1 cement : 1 sand) and then just enough water shall be added to make the mix plastic. On no account, the mortar shall be made soft or sloppy. The mix shall then be carefully inserted by hand into the joint.

Special care shall be taken for inserting the mortar into the portion of the joint underneath the pipe. When the cement mortar has been inserted, it shall be punched or caulked into the joint with wooden caulking tools, and more cement mortar shall be added until the space of the joint has been filled completely with tightly caulked cement. No fillet of cement shall be added.

No mortar which is older than 30 minutes shall be permitted for jointing. The cement mortar joints shall be cured at least for seven days before testing.

The inside of each pipe shall be carefully wiped out with a mop or scrapper sufficiently long to pass two joints from the end of the pipe and any projecting cement shall be removed.

All pipes entering the manholes should be set in cement mortar 1:3 and a completely watertight junction effected.
(b) Bituminous joints

If specified so this joint will be used. Asphalt and sand in the ratio of 1:7 shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

13.5.4 Testing of pipes

Testing of pipes shall be done wholly at contractor’s expense inclusive of apparatus, provision of water etc., and/or as per IS : 4127-1983.

After cement has had time to set, the pipes shall be tested in lengths between manholes in the following manner. In the lowest manhole a plug shall be inserted in the pipe. The disc in the pipe and at the upper manhole shall be fitted with a filling pipe with a right angle bend and an air cock. The length of pipe shall then be filled with water by means of the pipe connection on the upper disc. The air cock in the upper disc shall be kept open, while the pipeline is being filled to permit the escape of air.

When the pipes have been filled with water and air excluded, the air cock shall be shut and water shall be poured into a conical "Filler" attached to the testing and filling pipe of the disc in the upper manhole until water remains in the filler. The testing or filling pipe shall then be raised and fastened so that the height of the pipe is six feet, which will be the usual test pressure for stone ware pipe joints.

The test will be for an hour or such longer period as may be set by the Engineer. If the water level does not fall more than 25 mm in the length of 90 metre, the test may be considered satisfactory.

If it is found that certain pipe joints are leaking, the water shall be run off and joints recaulked with cement mortar and the test repeated till it is proved by the Contractor that the joints are leak-proof.

13.5.5 Concrete bedding, haunching & encasing

Unless otherwise specified in the Schedule of Quantities, all SW pipes shall be laid in accordance with IS: 4127-1983 As per site condition haunching or/and encasing of pipes with cement concrete may be required as per clause 4.2 & 4.3 of IS 4127-1983. The concreting shall be done with 1:4:8 cement sand concrete.

Where sewers have less than 1.2 m cover at places of heavy traffic, these shall be surrounded with mass concrete if directed by the Engineer.

13.5.6 Handling of pipes

While unloading, pipes shall not be dropped from the trucks/carts on the ground. Timber skids and steadying rope should be used while unloading or lowering in trenches. To avoid damage specially to spigot end, pipes should not be dragged on the hard surface.

13.6 Manholes

All manholes shall be of the size and type as given in the Schedule and shall be provided as per drawing or as directed by the Engineer. All the manholes shall be circular or other shape as shown in drawing. The bed shall be in cement concrete of Mark-10B (or 1:3:6 mix) (Size of coarse aggregate 40 mm and down) of 100 mm thickness or as shown in the drawing and shall be projected out 75 mm from the outside face of the wall all round. or as shown in the drawing. The working part including channeling, benching etc., made
of P.C.C. shall be of grade-15C (or 1:2:4 mix). All manholes shall be plastered inside with 1:3 cement plaster 20 mm thick and finished with a floating coat of neat cement unless otherwise specified.

Concrete used for precast RCC cover slabs shall be of grade 20C (or 1:1.5:3 mix) and shall be constructed as per drawing.

The top level of manholes shall be generally 100 mm above the surrounding ground levels or as directed by the Engineer. Channeling inside the manhole shall be done in smooth bends.

The end of pipe shall be neatly built in and finished in cement mortar 1:3.

Circular medium duty Cast iron water sealed manhole cover and frames, 560 mm dia (clear opening) and nominal weight 128 kg shall be provided for each manhole and shall be in accordance with IS:1726-1991 Manhole covers with double seals (Light duty) with wt. as specified in schedule of item shall be provided within compound near the buildings if specified so. If specified heavy duty cover and frames, either circular or double triangular type, shall be provided. Step irons shall be provided with two coats of bituminous paint and shall be as per drawing.

In cases where branch pipe sewers enter the manhole or main pipe sewer at a level more than 1m, from the main sewer, a drop connection shall be provided. The extra pipe length required for this connection will be paid under item for pipelines. No other extra payment will be allowed.

All exposed surfaces of cast iron frame and cover shall be painted with two coats of bituminous painting

13.7 Marker plates

Marker plate indicating the particular service installed shall be provided along the routes of pipes laid below ground. These shall be of mild steel, with the type of service and direction of flow, painted on it. The markers shall be set firmly in a concrete base and installed at all corners and turning points. Over straight runs markers shall be spaced at 100 m intervals generally.

14.0 ROAD WORK (RCC roads ie Rigid pavements only to be considered in this project)

A. FLEXIBLE PAVEMENTS

14.1 General

Road works in general shall be constructed according to the requirements to the various specifications and codes of practices of the Indian Roads Congress.

Works such as earthwork, masonry, concreting and the like, wherever they occur in association with construction of roads, shall be governed by the respective specifications of these series.

14.2 Trenching and Preparation of Subgrade

The surface of the formation of width equal to that of soiling coat shall first be cut to a depth below the proposed finished level equal to the combined depth of soiling and wearing coat, (due allowance being made for consolidation), and dressed parallel to the
finished profile. Any roots of bushes, trees etc., shall be taken out to the full depth and
the cavities thus formed shall be filled up and rammed by the contractor at his cost.

In slushy soil or in areas where water logging is frequent, adequate arrangement shall be
made for drainage of the area so that the sub-soil water level is kept as low as possible.

The sub-grade shall then be consolidated with a power road roller of 8-10 tonne capacity
by rolling with minimum of 5 numbers of passes till it is densely consolidated to the
satisfaction of the Engineer.

Surplus earth shall be disposed of as directed by the Engineer and the areas where it is
disposed of shall be neatly dressed.

All undulations of the sub-grade surface that might develop due to rolling shall be made
good with earth and sub-grade re-rolled.

14.3        Ash / Moorum Carpet

Wherever the ground is soft and slushy, ash carpet consisting of common boiler ash shall
be laid to 5 cm thickness over the subgrade and then rolled. In firm ground no ash carpet
is necessary and boulder soiling shall be laid directly over the sub-grade. If decided by
the Engineer, a bed of moorum of specified thickness shall be provided for to form a sub-
grade.

14.4.1      Boulder Soling

The width of the soling coat shall be 30cm (15cm on either side) more than that of the
wearing coat. Its depth shall be 15cm in cutting and 23cm in filling and made up soil,
unless otherwise specified in the schedule of quantities or shown in the drawing.

The edges of the soling shall be marked out by strings and stakes. Soling stone shall be
hand packed and set on edge with greatest length across the road. This shall be laid
closely in position on the sub-grade, firmly set with their broadest side downwards. The
joints shall be staggered. All interstices between the stones shall be wedged in with
locking smaller stones well driven into gaps to ensure tight packing and complete filling of
interstices. Such filling shall be carried out simultaneously with the placing in position of
soling stones and shall not lag behind.

After packing, surface shall be checked with template of approved shape and high and
low spots corrected by removing soling and re-packing. The top surface of the soling coat
shall be perfectly true to camber and grade.

The soling shall then be thoroughly consolidated with power roller of 8-12 tonne weight
depending upon the type of soling stones, starting at "edges" and working towards the
centre. In case of super-elevated curve the rolling shall commence from the inside edge
of the curve to the outside edge. The roller shall run over the same surface of soling at
least 10 times or more till the soling coat is well consolidated to the satisfaction of the
Engineer. The surface shall be checked by templates and any disturbance in grade or
camber corrected after every rolling and finally consolidated. After that, at least 50mm
thick moorum shall be laid on top of soling coat and rolled with water to proper
compaction so that the top surface seems smooth. The rate for soling coat shall be inclusive
of the cost of the moorum as blinding materials for which no separate payment shall
be made.

14.4.2   Laterite soling
In case of laterite soling the thickness of soling shall be as follows:

(i) For road width of 7m and above the sub-base shall consist of two layers of laterite stones 150mm maximum size. The sub-base shall be rolled to a thickness of 230mm after compaction.

(ii) For road width of 4m to 7m, the sub-base shall consist of one layer of laterite stone of 150mm maximum size consolidated to 115mm thick.

(iii) A layer of moorum, 33.3% in volume of laterite, shall be spread over the laterite to a uniform thickness and rolled with 8 tonne roller with constant watering until the mixture penetrates into the voids of laterite layer. Care shall be taken to maintain the camber and slopes.

Other steps for laying, compacting etc. of the laterite soling shall be same as given under clause 14.4.1 "Boulder soling".

14.5 Kerbs

Concrete or stone kerbs, where shown in drawings, shall be fixed in position after laying and consolidation of soling. They shall be fixed true to line and level and secured in position by approved means.

14.6 Water Bound Macadam Surfacing

The construction of water bound macadam shall be carried out according to IRC : 19-1981 "Standard Specification and Code of Practice for Water Bound Macadam".

14.7 Preparation of Base and Shoulders

The subgrade shall be reshaped to the required grade and camber. Where water bound macadam is to be laid over existing black top surface, 50 mm x 50 mm furrows shall be cut in the existing surface at 1 m intervals inclined 45 degree to the centre line of the carriageway, before laying of coarse aggregates. Necessary arrangements shall be made for the lateral confinement of aggregates by constructing shoulders in the form of two parallel mud walls 20 x 15cm which shall be made along the outer edges of the wearing course.

14.8 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly and evenly upon the prepared base in required quantities from stock piles along the roadside or directly from vehicles. In no case shall these be dumped in heaps directly on the base. The aggregates shall be spread to proper profile by using templates placed across the road about 6m apart. Where possible, mechanical devices shall be used to spread the aggregates uniformly.

The water bound macadam course shall be constructed in layers of not more than 75 mm thickness. However, the Engineer may permit courses of 100 mm compacted thickness to be constructed in a single layer. Each layer shall be tested by depth blocks. No segregation of large or fine particles shall be allowed.

14.9 Rolling

The coarse aggregates spread as described above shall be compacted to full width by rolling with either three wheel power roller of 6 to 10 tonnes capacity or an equivalent vibratory roller. The weight of roller shall depend on the type of coarse aggregate.
The rolling shall begin from edges and after the edges have been compacted, progress gradually towards the centre, parallel to the centre line of the road, uniformly lapping each preceding rear wheel track by one half width. On super elevated portions, rolling shall commence from the lower edge. Where screenings are to be applied, rolling shall be discontinued when the aggregates are partially compacted with sufficient voids to permit application of screenings. Where screenings are not to be applied, as in the case of crushable aggregates compaction shall be continued until the aggregates are thoroughly keyed, with no creeping of stones ahead of the roller. Slight sprinkling of water may be done during rolling, if necessary.

Rolling shall not be done when the subgrade is soft or yielding nor when it causes a wave like motion in the base course. If irregularities develop during rolling, and exceed 12 mm when tested with a 3m straight edge, the surface shall be loosened and aggregates added or removed before rolling again. The surface shall be checked by template for camber. In no case shall screenings be used to make up depressions.

14.10 Application of Screenings

After coarse aggregates have been rolled, screenings to fill the interstices shall be applied gradually over the surface in thin layers. Dry rolling shall be done when the screenings are being spread, so that the jarring effect of roller causes them to settle into the voids of the coarse aggregates. Damp and wet screenings shall not be used and the spreading, rolling and brooming of screenings shall be taken up on sections which can be completed within one day's operation.

14.11 Sprinkling and Grouting

After application of screenings, the surface shall be copiously sprinkled with water, swept and rolled. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well blended and firmly set and a grout of screenings and water forms ahead of the wheels of the roller.

14.12 Application of Binding Material

After the application of screenings, approved binding material, where it is required to be used, shall be applied at a uniform and slow rate in two or more successive thin layers to a thickness of 2.5 cm. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with brooms, so as to fill the voids properly. This shall be followed by rolling with a 6-10 tonne roller, during which, water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry of binding material and water forms a wave ahead of the wheels of moving roller.

14.13 Setting and Drying

After final compaction the road shall be allowed to cure overnight. Next morning, hungry spots shall be filled with screenings or binding material, lightly sprinkled with water and rolled. No traffic shall be allowed till the macadam sets.

14.14 Surface Evenness

The surface evenness of completed water bound macadam course in longitudinal direction shall be within 12 mm when tested with a 3 m straight edge and in cross profile within 8 mm when checked with a template.
14.15 Bituminous Pavements

14.15.1 Bitumen premix carpet with seal coat

The consolidated thickness of this type of treatment shall be 2cm/2.5cm/4cm or as specified.

14.15.1.1 Surface preparation

Water bound macadam surface on which black topping is to be provided shall be thoroughly cleaned of dust, loose materials, caked mud and other foreign material with the help of wire brush, chisel, picks etc. Cleaning shall be such as to expose the stone metal to a depth of about 6mm without dislodging the interlock of the metal. All dust and other materials thus removed shall be thrown away at a suitable place as directed by the Engineer.

Any potholes, depressions and undulations found after cleaning shall be made good with premixed chippings, and well rammed.

14.15.1.2 Tack coat

Just before the application of tack coat, the surface shall be thoroughly cleaned by brooms and then by fanning with gunny bags.

Bitumen of specified grade heated to a temperature of 177 to 188 degree 'C' shall be spread on the prepared surface uniformly at the rate of 0.75 kg/sq.m. by means of sprayers. It shall be applied just ahead of and keeping pace with, laying of premix carpet.

14.15.1.3 Preparation of mix, laying & consolidation

The stone grit (aggregate) shall be surface dry and contain not more than 2% moisture before use. It shall be first screened of dust and measured in boxes and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion given in the table below. The aggregate shall be heated to facilitate mixing with the binder in cold weather, where so directed by the Engineer.

The binder heated in boilers, to a temperature of 149 to 177 degrees C or as specified for the grade used and maintained to that temperature, shall be drawn off from the boiler into a suitable container or in bucket gauged to show the weight of bitumen in it. This shall then be poured over the aggregate in the mixer at the correct rate of 64 Kg/cum of aggregate or as specified and mixing started and continued till aggregate is uniformly coated with bitumen.

Immediately after applying the tack coat, the hot mix shall be discharged from the mixer, carried to the road surface and spread to a thickness sufficient to achieve after consolidation the specified thickness. Rakes or drag spreaders shall be used for spreading the mixture. When the premix has been laid for a length of 15-20 metres it shall be rolled. Rolling shall commence from edges and proceed towards the centre. The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. Any high spot or depression which become apparent shall be corrected by addition or removal of premix materials.
Further the prepared finished surface shall be protected from the traffic for 24 hrs or such period as may be specified by the Engineer.

14.15.1.4 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below, unless otherwise specified.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Consolidated thickness of premix carpet</th>
<th>Stone chips (cum)</th>
<th>Sand (cum)</th>
<th>Tack coat (kg)</th>
<th>Binder Carpet (kg/cum)</th>
<th>Seal coat (kg/cum)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Using Paving bitumen 80/100 or 30/40 grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Priming tack coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>on a water bound macadam surface</td>
<td></td>
<td></td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>on an existing black top surface</td>
<td></td>
<td></td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Carpet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 cm</td>
<td>2.4 (10 mm nominal size)</td>
<td></td>
<td></td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 cm</td>
<td>3.0 (10 mm nominal size)</td>
<td></td>
<td></td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0 cm</td>
<td>4.8 (12 mm nominal size)</td>
<td></td>
<td></td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Seal Coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Dry area (Premixed sand seal coat)</td>
<td>0.6</td>
<td></td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Wet area (Liquid seal coat with chips)</td>
<td>0.9</td>
<td></td>
<td>98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14.15.2 Seal coat

In dry areas where rainfall is under 150cm per year a premix sand seal coat shall be applied immediately after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen. The aggregates shall be dry and suitably heated to a temperature directed by Engineer before the same are placed in the mixer of suitable design. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with binder. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with premix materials, the surface shall be rolled with 6 to 8 tonne power roller. Rolling shall be continued till the premix material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

In wet areas where rainfall is above 150cm per year a liquid seal coat with chippings (not sand) shall be applied after laying the carpet. The binder shall be heated in boilers of
suitable design, to the temperature appropriate to the grade of bitumen and spread on the surface preferably using mechanical sprayers. Immediately following the application of the binder, stone chippings in a perfectly dry condition shall be uniformly spread on the surface. Immediately after the application of the cover material, the entire surface shall be rolled with 8-10 tonne road roller.

14.15.3 Surface dressing

The surface shall be prepared in the same way as that for premix carpet work as per 14.15.1.1. Depression or pot holes, if any, shall be repaired as indicated.

After the surface has been prepared and is in perfectly dry condition, bitumen heated in the same manner as for premix carpet, shall be sprayed over the surface preferably using mechanical sprayers. It shall be ensured that there is even and uniform distribution of bitumen on the surface. Spraying shall be carried out parallel to the centre line of the road.

Immediately following the application of bitumen, stone chippings in a perfectly dry condition, shall be uniformly and evenly spread as specified in the item, over the entire sprayed surface. Spreading may be done preferably by means of mechanical gritter. Finally the entire surface shall be broomed to ensure perfect uniform spreading.

The final surface shall be checked by means of camber board etc. The spread surface shall be rolled with 6 to 8 tonne roller till there is sufficient bondage of chippings with bitumen. The finished surface shall be thrown open to traffic on the following day.

14.15.4 Premixed Bitumen Concrete

14.15.4.1 General

In this type of road carpet a mixture of sand and stone aggregate is used as aggregate producing a dense mixture. Seal coat is not necessary as the sand used in the mix works up to the surface and forms a seal by itself. The consolidated thickness of this type of treatment shall vary from 4cm to 7.5cm as specified.

14.15.4.2 Surface Preparation

Same as in para 14.15.1.1 above.

14.15.4.3 Tack Coat

Same as in para 14.15.1.2 above.

14.15.4.4 Preparation of Mix, Laying & Consolidation

Para 14.15.1.3 shall generally apply except that the mixing shall be done in two stages. The stone aggregate of the the correct specified size and in the proportion shown in the table above shall be fed into the mixer to which 2/3rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the stone metal is well coated, the sand in the specified proportion and the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

The premix shall be emptied on to wheel barrows or stretchers and carried to the site of work. It shall then be spread uniformly on the road surface with rakes or drag spreaders immediately after applying the tack coat to a thickness sufficient to achieve after consolidation the specified thickness. When the premix has been laid for a length of 15-
20m it shall be rolled. Rolling shall commence from edges and proceed towards the centre.

The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. After preliminary rolling, all honeycombs, any high spot or depression which become apparent shall be corrected by addition or removal of premix materials. Camber and grade shall be checked at every stage to ensure correctness and any defect found shall be rectified.

14.15.4.5 Materials

Quantity of materials required per 100 sq.m of road surface shall be as given in the table below unless otherwise specified.

**BINDER**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Thickness of consolidated bitumen concrete surfacing</th>
<th>Tack coat (kg)</th>
<th>Hot Bitumen (cut back)/ Paving Bitumen 80 / 100 grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bitumen concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stone aggregate (kg / cum)</td>
</tr>
<tr>
<td>1.</td>
<td>4 cm, 5 cm, 6 cm &amp; 7.5 cm cm</td>
<td>75</td>
<td>560</td>
</tr>
</tbody>
</table>

**Aggregate**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Thickness of compacted bitumen concrete surfacing</th>
<th>Stone aggregate (cum / 100 sqm)</th>
<th>Coarse sand (cum / 100 Sq.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4 cm</td>
<td>(12mm nominal size)</td>
<td>1.90</td>
</tr>
<tr>
<td>2.</td>
<td>5cm</td>
<td>(20mm nominal size)</td>
<td>2.40</td>
</tr>
<tr>
<td>3.</td>
<td>6cm</td>
<td>(60% 40mm nominal size)</td>
<td>2.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(40% 25mm nominal size)</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>7.5 cm</td>
<td>(60% 50mm nominal size)</td>
<td>3.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(40% 40mm nominal size)</td>
<td></td>
</tr>
</tbody>
</table>

The nominal size of Coarse Aggregate herein shall mean as defined below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Nominal size of coarse aggregate</th>
<th>Designation of IS sieve through which the aggregate shall wholly pass</th>
<th>Designation of IS sieve through which the aggregate shall be retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>40 mm</td>
<td>50 mm</td>
<td>25 mm</td>
</tr>
</tbody>
</table>
### General Technical Specification

**Sl. No.** | **Nominal size of coarse aggregate** | **Designation of IS sieve through which the aggregate shall wholly pass** | **Designation of IS sieve through which the aggregate shall be retained**
---|---|---|---

ii) | 25 mm | 40 mm | 20 mm

iii) | 20 mm | 25 mm | 12.5 mm

iv) | 12 mm | 20 mm | 10 mm

v) | 10 mm | 12.5 mm | 6.3 mm

vi) | 6 mm | 10 mm | 2.36 mm

### 14.15.5 Surface evenness

The finished surface of premix carpet and bituminous concrete shall be tested with a straight edge 4.5 m long and any irregularity greater than 6mm shall be corrected.

### 14.16 Berms

Shoulders and berms shall be prepared as shown on the drawings. Work on making berms shall not lag more than 100 metres behind the water bound macadam consolidation. Suitable drains shall be cut on the berms so that the water bound macadam surface is kept drained till bituminous macadam is laid.

### 14.17 Kerbs

Kerbs shall be laid and set in place before completing the bituminous or concrete wearing surface as well as the wearing surface of footpath. Setting shall be done in mortar where so specified with Schedule of Items. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of footpath.

Where the road edge forms a curve, the kerbs shall follow such curve. Gaps shall be left as shown in drawings or as may be required to provide for drainage.

### 14.18 Bridges and Culverts

Bridges and culverts shall be constructed according to the specifications of Indian Roads Congress. Relevant chapters of earthwork, concrete, masonry etc., of these series shall apply.

### 14.19 Boulder Pitching

Wherever specified, boulder pitching shall be provided at the inlet and outlet of pipe culverts, or for embankments of bridges. The subgrade shall first be dressed to level or slight slope as indicated. The transverse slope of the pitching shall be made strictly in accordance with the drawings or as directed by the Engineer.

### 14.20 Scarifying & Dismantling

Where a new carriage-way abuts or includes an existing carriage-way and the Engineer so directs, the surface of the latter shall be scarified, adjusted and reshaped to conform
with the existing and new camber or crossfall. Materials from the existing road shall be used or disposed off as directed by the Engineer. Where dismantling of the existing road has been specified, the various layers of the road viz., bituminous macadam, water-bound macadam and soling shall be scarified separately. Scarifying can be done either by hand picks, or by means of scarifiers fixed to the roller. When a roller is used for scarifying, crushing of the metal shall be avoided by moving the metal clear of roller wheels after the scarifier has passed over it. The loosened material shall then be combed by means of rakes to bring out most of the larger stone. If necessary, the larger stones thus collected shall be screened to separate fine particles if any.

The remaining metal shall then be removed and screened to recover reusable metal. Different grades of metal shall be stacked separately and measured.

14.21 Divisions

Where the construction of the road or culvert or bridge is in progress, the road shall be closed to traffic and a suitable diversion shall be provided for traffic by the Contractor, as directed by the Engineer.

The road shall be closed by the erection of barriers and suitable sign boards at both ends which shall be provided with lights at night. Both during night and during day, one man shall be posted at each barrier to suitably divert the traffic and to keep the light burning during the night.

14.22 B. RIGID PAVEMENTS

The rigid pavement consist earthwork, Granular Subbase, Dry Lean Cement Concrete and concrete slab.

14.22.1 Earthwork

Earthwork item consist embankment, subgrade, earthen shoulders and backfills. The physical property of the soil for embankment should be as follows:

- Maximum dry density of soil for embankment should be 1.60 gm/cc.
- Maximum dry density of soil for subgrade should be 1.75 gm/cc.
- The field density of soil for embankment should be 95% with respect to maximum dry density.
- The field density of soil for subgrade should be 97% with respect to maximum dry density.

The embankment and subgrade material shall be spread in layers of uniform thickness not exceeding 250mm compacted thickness over the entire width of embankment by mechanical means and compacted as stated above. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements. The compaction shall be done with the help of vibratory roller of 80 to 100
kN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

When density measurements reveal any soft areas in the embankment / sub-grade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

14.22.2 Granular Sub-base

This work shall consist of laying and compacting well graded material on prepared subgrade. The thickness of this material shall be 150 mm. The material to be used for the work shall be natural sand, moorum, gravel, crushed stone or combination thereof depending upon the grading required. Materials like crushed slag, crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The size of the aggregate should be in between 75 mm to 0.075 mm. This material contains aggregate and soil which has plastic limit less than 6%. The quantity of the aggregate should be 55% by weight of total material and quantity of the soil should be 45% by weight of total material. The compaction should be done the help of vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller.

Rolling shall be continued till the density achieved is at least 98% of the max. dry density.

14.22.3 Dry Lean Concrete

The dry lean concrete for cement concrete pavement shall be provided over the prepared granular subbase. The thickness of the dry lean concrete shall be 150 mm. the size of the aggregate for dry lean concrete shall has 26.50 mm to 75 micron. The grade of the concrete shall be M15. The mix shall be proportioned with a maximum aggregate cement ratio of 15:1. The water content shall be adjusted to the optimum for facilitating compaction by rolling. The minimum dry density obtained shall be 97% of that achieved during the trial length construction.

Double drum smooth wheeled vibratory rollers of minimum 80 to 100 kN static weight are considered to be suitable for rolling dry lean concrete.

The final lean concrete surface on completion of compaction and immediately before overlaying shall be well closed free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects.

14.22.4 Cement Concrete Slab
The cement concrete slab shall be provided over the prepared dry lean concrete surface. The thickness of the cement concrete slab shall be 250 mm. The maximum size of the coarse aggregate shall not exceed 25mm for pavement concrete. Continuously graded or gap graded aggregate may be used, depending on the grading of fine aggregate. No aggregate which has water observation more than 2% shall be used in the cement concrete mix. The fine aggregate shall consist of clean natural sand or crushed stone sand or a combination of both. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. Water used for mixing and curing of concrete shall be clean and free from injurious material. The longitudinal joint and transverse joint of the slab shall not be exceed 4.5 m. The joint shall consist of a mechanical sawn joint group 3 to 5 mm wide and 1/4 to 1/3 depth of the slab. The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide type having flexibility, resistance to age hardening and durability. The grade of the concrete shall be M35.

**ADDL POINTS TO BE CONSIDERED WHILE DESIGNING RIGID PAVEMENTS**

a) At Tee Jn. Or Squares turning radius suitable for haul pack dumpers/tractors must be taken into account

b) No where Rail tracks are to be kept below road line

c) Generally all road rail level crossings are provided perpendicular to road. However skew crossing will be provided wherever perpendicular crossing is not feasible due to space limitations.

**15.0 WATERPROOFING TO ROOFS & WATERPROOFING PAINTS**

**15.1 Scope**

This chapter deals with different types of waterproofing on roof.

**15.2 Material**

The materials shall conform to Part-I and only membrane type water proofing shall be considered.

**15.3 General Workmanship**

The waterproofing to roofs being specialised works the Contractor shall get these done by specialised firms/agencies.

**15.4 Painting with Hot Bitumen**

The surface to be painted shall be thoroughly dried and then cleaned, with wire brushes and cotton or gunny cloth, of all loose materials and scales. The surface shall further be cleaned with a piece of cloth lightly soaked in kerosene oil. Bitumen shall be brought to the site in its original container and this shall not be removed from site till the painting job is completed. Before applying the main coatings of hot bitumen paints, one coat of bituminous primer shall be applied. The number of coats of hot bitumen shall either two coats or as specified in the Schedule of Items. The bitumen of approved quality (either of grade 80/100 or 30/40) or as specified shall be applied to the surface after heating it to the manufacturer's specifications. Care shall be taken to see that no blank patches are
left and the quality of bitumen to be spread shall be as specified and shall be to the satisfaction of the Engineer.

15.5 Painting with Bitumen Emulsion

Before applying, the surface shall be cleaned thoroughly. Generally two coats of Bitumen Emulsion are provided over a coat of emulsion primer. Since the painting is with emulsion, the surface need not be made dry.

15.6 Waterproofing of Roof

15.6.1 With bitumen felt

Prior to laying the insulation, roof gradient shall be checked. If necessary, the roof shall be re-graded by screed to ensure everywhere a run off gradient of not less than 1 in 120. The screed shall consist of one part cement and four parts medium to coarse sand by volume. The screed shall be cured for 7 days. The surface shall then be cleaned of all foreign matter by wire brushing and dusting.

Waterproofing unless specified otherwise in drawings shall be the "heavy treatment type" with primer coat as described in IS : 1346-1991. The method of laying roofing treatment, surface finishing with pea gravels, special mode of treatment for drain outlets, projecting pipes, parapet walls, expansion joints, gutters, timber roofs etc., shall conform to IS : 1346-1991. The number of layers of felts shall be as specified in the drawing or Schedule of Items. The bonding bituminous material shall be of grade 30/40 or as specified and the minimum quantity of hot bitumen to be applied, shall be 1.2 kg/m². Unless specified otherwise, the bituminous felts shall be hessian bases of Type-3 Grade-2. Pea gravel finish may be substituted by a coat of bituminous aluminium paint, where so specified in the Schedule of Items.

The cement mortar used for filling the chases shall be of mix 1:4 and the cement concrete for fillets shall be of the same grade as the roof slab.

Where special surface finish with precast concrete or clay tiles is specified, it shall be in accordance with the relevant chapter of this series.

15.6.2 With bitumen mastic

The work shall be carried out generally in accordance with IS : 4365-1967 "Code of Practice for Application of Bitumen Mastic for Waterproofing of Roofs" or according to the manufacturer's specifications. The work shall be carried out by a firm of specialists in the trade.

The type of underlay or primer, thickness of application, surface finish etc., shall be as shown on drawing or described in the Schedule of Items. Bitumen melting shall be done in a mechanical mixer by gradually heating to about 200 degree ‘C’. Coarse aggregate where required shall be added to the hot bitumen and stirred.

Each coat shall be spread evenly and uniformly by means of a float to the required thickness. Timber gauges shall be used to regulate the thickness. Particular care shall be taken to tuck the mastic into grooves on vertical surfaces, at joints, around pipes or other projections and at junction of adjoining bays.
15.6.3 Waterproofing of RCC roof with Lime concrete and Pressed clay titles.

Lime concrete shall consist of broken brick aggregates and lime. Proportion of brickbat coba shall be 2.5 parts of brick jelly to one part of lime. The brick jelly shall be hard, well burnt and of size varying from 12mm to 25mm.

The lime concrete is then laid over roof to slope to give specified thickness and in slope of 1 in 80 or as shown on the drawing for proper roof drainage as per roof drainage plan. The lime concrete is then to be beaten in the manner approved by the Engineer for 48 hours or as directed with hand beaters.

If the surface during the process of compaction becomes so uneven that water lodges in pools, the surface shall be pricked up, and fresh concrete spread and consolidated as necessary to obtain an even surface.

The concrete shall then be cured by sprinkling water and allowed to harden for a period of not less than six days before laying the roof finish.

Roof shall be finally finished with one coarse of machine pressed clay titles 20 mm thick laid over a 12mm thick of 1:3 mix cement mortar mixed with 5% crude oil by weight of cement mixed in mortar. The pressed clay tiles shall be immersed in water for two hours before being used. The side joints of the tiles shall be more than 60 mm thick set full in mortar. Before the work dries up completely, the tile joints shall be raked out and pointed with cement mortar 1:3 mixed with crude oil which shall be 5% by mass of cement. The joints shall be well rubbed over with thin bar trowel and excess of mortar scrapped off until the surface of the pointing attains a black polish and becomes hard. As the work proceeds, it shall be kept thoroughly wetted until the mortar has set firm and hard. Watering shall be continued for three weeks after construction.

Lime concrete and tiles shall be taken up the parapet walls to a height of 150 mm or as shown in the drawing.

The specification of pressed clay titles shall be as given in IS:2690-1975 (Part-I). The specification of crude oil shall be as per IS:2119-1980.

The areas around drain pipes shall be properly finished with provision of adequate slope.

The contractor shall give guarantee for any/all types of waterproofing for a period of 7 years against bad of faulty material and construction and shall rectify the same at his own cost during the guaranteed period.

15.7 Waterproofing for Basement

15.7.1 The specification covers the requirements of waterproofing of basements, tunnels, ducts, pits, bunkers, etc.

The material used shall be bitumen felt type-3 of grade-2 conforming to IS : 1322-1982, together with the specified bonding material and primer.

Waterproofing shall be provided on the outside of walls and top of the floors and shall be carried 150 mm above ground level.

The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

i) For depths upto five metres below ground : 2 layers.
ii) For depths beyond five metres: 3 layers.

The method of laying the bitumen felts and workmanship shall in general conform to IS: 1609-1991.

Waterproofing work shall be taken in hand only when the sub-soil water level is at its lowest, the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed. For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps. In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area. Adequate arrangements shall be made to prevent the sides of excavation from slipping while the work is in progress.

The base concrete of mud-mat shall be rendered smooth by a 20 mm thick sand-cement plaster (6:1). Any sharp corner over which the waterproofing course is to be laid shall be eased out by means of cement mortar fillets 7.5 cm in radius.

The surface must be dry before the next operation is carried out. Blown bitumen conforming to IS: 702-1988 shall be applied hot over the prepared surface at the rate of 1.5 kg/m² for the first layer and for every other subsequent layer(s). The laying of felt over the bitumen so applied shall always commence on the floor, and shall be carried to the walls only after treatment of the floor is complete. The minimum overlapping of joints at sides and ends of felts shall be 10 cm. Joints for subsequent layers of felt shall be staggered. All joints shall be completely sealed by blow lamp.

A protective flooring of either flat bricks in cement mortar 1:3 or 6 cm thick cement concrete type M15B or a coat of cement sand plaster (1:3) 4 cm thick shall be constructed over the waterproofing treatment to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way, the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth, where necessary with a coat of cement plaster 1:5, the felts shall be laid as for the floor ensuring that the surface to be treated is dry and then a protective brick wall, half-brick nominal thickness shall be built in cement mortar 1:6 over the projecting mud-mat, the space between the wall and felt being grouted with cement slurry. Sufficient care shall be taken to ensure a perfect bond between the waterproofing on the floor and that on the walls.

The treatment on the wall shall be carried 150 mm above the surface of ground and tucked into a groove 6.5 cm wide and 7.5 cm deep, the chase being filled with cement mortar (1:4).

Where waterproofing is done to the roof of an underground structure, such as a tunnel, it shall be done in a similar way. The structural concrete shall be rendered smooth, hot bitumen and bitumen felts applied in the same way as for the floor and walls, and over this shall be laid a protective layer of cement concrete grade M10C, 7.5 cm thick.

15.7.2 With epoxy based emulsion

Over the mud-mat a 20 mm plaster is to be provided to make the surface even.

On the plastered surface of the mud-mat, three coats of epoxy based leakproof emulsion shall be applied with reasonable gap between each coat in order to permit sufficient drying time.
Precaution should be taken that during the process of rod binding if any damages happens it should be immediately rectified by making patch painting on the affected portion only and as such a complete vigilance is to be kept to rectify the defect.

After the rod binding is over the concreting should be done with high polymer based, chloride and sulphide free cement waterproofing additive/admixtures @ 2% by weight of cement all through the floor area and all through the vertically raised walls of four sides which shall remain underground upto a depth of 8 metre and above from ground level.

After the concreting and immediately after de-shuttering cleaning of the concrete surface on the external faces of the walls are to be done and then three coats of epoxy based leakproof emulsion shall be applied with a reasonable gap between the each coat before back filling. If the back filling is with hard material again a protective layer of plaster shall also be applied on the external faces of walls in order to avoid damages on the painted surface.

If the back filling is with soft sandy or alluvial soil there is no necessity for protective layer of plastering as mentioned above.

Epoxy based paint can be applied on the wet surface hence there shall be no stoppage of the normal progress of the project works.

15.8 Surface Application

Waterproofing done by surface application of bitumen based or epoxy based material shall conform strictly to the recommendations of the manufacturer. The work shall be carried out by a firm of specialists in the trade.

15.9 Guarantee

For the waterproofing on the roof as well as for underground basements the Contractor shall give guarantee in writing for the period of 7 to 10 years as specified in the Schedule of Item. For such guarantee the Contractor shall get guarantee from the manufacturer/specialised firms and forward the same to the Engineer. However, the Contractor shall be fully responsible for the serviceability of the waterproofing treatment throughout the guarantee period and any leakage during that guarantee period shall be stopped by the Contractor at no cost to the Owner and without disturbing working facility of the Owner.

15.10 Water proofing course with Fibre glass R.P. tissue

15.10.1 Scope

This section covers the furnishing of all labour, equipment and performing all operations necessary to complete to provide water proofing course of Fibre glass R.P. tissue all in accordance with the drawing and these specifications.

15.10.2 Terminology

For the purpose of these specifications the following definitions detailed hereinafter shall apply.

15.10.3 Preparation of surfaces
Surface to receive waterproofing shall be dry, free from dirt, loose particles and foreign materials. Projections which might puncture the membrane shall be removed and voids and crevices shall be filled in prior to the start of work.

Adequate covering shall be provided during this work to avoid splashing or staining of the adjacent work and surfaces. Any work or surface splashed or stained shall be thoroughly cleaned to the satisfaction of the Engineer. Joints in the tissue felt in the different layers shall be staggered.

15.10.4 In built-up roofing

Application

i) Suitable slope shall be provided in the roof as per manufacturers specifications. Heat insulation may also be provided if necessary.

ii) Prime the plastered surface primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface and should be left till the time it is touch-dry.

iii) Apply first coat of hot bitumen @ 1.8 Kg/sqm.

iv) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

v) Apply second coat of hot bitumen @ 1.8 Kg/sqm.

vi) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry.

vii) Apply third coat of hot bitumen @ 1.8 Kg/sqm.

viii) Embed third layer of fibre glass RP tissue.

ix) Apply fourth coat of hot bitumen @ 1.8 Kg/sqm.

x) Finish with gravel grit @ 0.006 cum per sqm.

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.

15.10.5 Specification

Water proofing medium

i) By impregnation into the fibre glass reinforcement membrane forms a monolithic mass.

ii) Prevents the penetration of water/moisture.

iii) Acts as a top dressing.

Layer

A single thickness of fibre glass tissue impregnated with bituminous compound.
Multiple layer

2 or more layers of fibre glass tissue laid consecutively with overlapping joints and impregnation with bitumen.

Bitumen/primer

A liquid bitumen of low viscosity which penetrates into a prepared surface upon application.

Half-brick masonry shall be of approved quality 50 class brick work in cement mortar 1:4 (1cement : 4 sand). Plaster should be in cement mortar 1:4 (1cement : 4 sand). Sand should be fine sand conforming to IS 383

Application

Suitable slope may be provided in lean concrete, if necessary. Over this, 12mm thick plaster with cement mortar 1:4 (1cement : 4 coarse sand)is to be laid.

Prime the plastered surface with primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface & then should be left till the time it is touch dry.

Water proofing shall be as follows :-

i) Apply first coat of hot bitumen @ 2.4 Kg/sqm.

ii) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

iii) Apply second coat of hot bitumen @ 2.4 Kg/sqm.

iv) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry.

v) Apply third coat of hot bitumen @ 2.4 Kg/sqm.

vi) Embed third layer of fibre glass RP tissue after the surface of the second layer has become touch-dry.

vii) Apply fourth coat of hot bitumen @ 2.4 Kg/sqm.

viii) Embed fourth layer of fibre glass RP tissue after the surface of the third layer has become touch-dry.

ix) Apply fifth coat of hot bitumen @ 2.4 Kg/sqm.

x) A layer of 12mm thick fine sand is to be laid after completing the above operations. The layer of sand will not be applied on vertical walls.

The surface should be finished with half-brick masonry in cement mortar 1:4 (1cement : 4 coarse sand).

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.
General

The work will be carried out by specialists in the trade. Workers shall be provided with gum boots and hand gloves. There shall be no air pockets. Corners shall be treated flush without any air pockets or voids.

Measurement

The unit will include supply of materials, transport, preparation of surface, application of water proofing treatment, plastering, masonry work etc., as specified herein. The measurement of the item will be in square metres nearest to the second decimal of the concrete surface which is to be damp-proofed.

15.11 Water proofing course with P.V.C sheets/ membranes

15.11.1 Jointing

The adjacent lengths of the P.V.C sheets shall be jointed by giving an overlap of 25mm, one over another by sealing with the approved adhesive. A minimum width of the sheet, as specified in the item, shall be used without any joint. Jointing of the sheets, to the extent possible and practicable, shall be done at the site workshop.

15.11.2 Laying

i) Horizontal areas: The base concrete shall be rendered smooth by cement sand plaster 1:6 mix of 20mm thick unless otherwise specified. It shall be ensured that there are no sharped c rivices, projections etc which may puncture and damage the sheet. P.V.C sheets shall then be evenly laid over the smooth rendered surface while it is green.

After laying of sheets a protective cover shall be laid over it. This cover may be of 1:6 cement sand mortar bed of thickness 20mm and above, flat brick/tile soling over cement sand mortar bed, any other suitable layer or thermal insulation cover as specified in the item. However care is to be taken that sheets do not get damaged while laying the protective cover. The horizontal layer of P.V.C sheets shall be carried over to a minimum of 150mm height and tucked in to the connecting vertical walls as in the case of roof parapets, if there is no provision of continuous laying of the sheets in the adjacent vertical surface.

ii) Vertical surfaces

On vertical concrete surfaces the P.V.C sheets shall be fixed along with the form work with the knobs projecting toward concrete. The sheets shall be clamped on the top of the form work to keep it in position. Concrete is then poured and knobs are locked in it. After the forms have been stripped off, all the tie bolt holes, cuts and other damages are sealed with additional patches of sheets as per manufacturer’s specification.

In case good quality of soil, completely free from foreign materials like stone piece, hard lumps and rubbish etc, is available, it can be used directly as a back fill. Otherwise a half brick wall or any other measure as specified shall be provided as a protection barrier over the projecting base of the concrete/mud mat. The top edge of the sheet shall be tucked into a chase to be subsequently sealed with cement sand mortar of 1:4 mix.

In case of sheets being laid both on horizontal and adjacent vertical surfaces, the horizontal sheets shall be carried on the vertical portion as one monolithic layer.
15.11.3 Agency

The execution work including jointing, laying and testing etc. shall be done by a specialised agency duly approved by the Engineer.

15.11.4 Testing

After laying is complete, the sheets shall be tested by an Electronic Pin hole detector for pin holes, cuts and other damages etc. All such portions shall be patched suitably with additional sheets as directed and again test checked.

15.11.5 Expansion joints

All Expansion Joints etc of dimensions as specified, shall be filled up by Polymer Sealant of pourable grade as per manufacturer's specification on the P.V.C sheets locked in the joint.

15.11.6 Guarantee

The contractor shall guarantee the water tightness and leak proofing of the structure for a period of ten years after certified completion and handing over of the jobs by furnishing a free maintenance guarantee as per prescribed format and as specified.

15.12 Waterproofing with Non-Shrink Polymeric Waterproof Grouting Compound

15.12.1 Work Included

The Contractor shall furnish materials, labour, plant, equipment and tools to complete the work as specified and/or as shown in drawings.

15.12.2 Materials

Cement

Ordinary portland cement shall conform to IS : 269-1989 and portland blast furnace cement shall conform to IS : 455-1989.

Aggregates

All aggregates shall conform to IS : 383-1970 Fine aggregates shall be approved river or pit sand.

Cement waterproofing compound

All cement waterproofing compound shall conform to IS : 2645-1975 and shall be of approved quality.

Solvent less resin

High build polymeric surfacing which forms a thick resilient and flexible membrane on concrete with high resistance to oil and water.

Nozzle
15 mm dia threaded G.I. pipes of suitable length plugged at both ends.

**Super plasticiser**


**15.12.3 Waterproofing of underground structures**

Waterproofing shall be carried out as per the approved manufacturer's specification and as stated below:

**15.12.3.1 Raft**

The sub-base (PCC) of the underground structure shall be cleaned of all dirts and kept dry by continuous pumping of water. 20 mm thick plaster with cement-sand mortar (1:3) mixed with approved cement waterproofing compound as per manufacturer's specification shall be laid on top of the sub-base. The plaster shall be finished smooth with a steel trowel.

The plastered surface shall then be painted with two (2) coats of approved solvent less resin to form a thick resilient and flexible resinous membrane over the plastered surface.

Threaded nozzles of 15 mm dia and of suitable length shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the whole raft, prior to casting of RCC raft. Similar nozzles will also be placed along the construction joint, if any, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting clogged by concrete. Similar nozzles shall also be post fixed at critical points, if required. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete which shall be at least M20 grade as defined by IS : 456-1978 and the water cement ratio of the concrete shall not exceed 0.45. Adequate precaution shall be taken to keep the nozzles vertical while concreting.

Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the instructions of the manufacturer. When the injection operation is over the nozzles shall be sealed with a sealing compound as per manufacturer's specification and instruction.

**15.12.3.2 Vertical wall**

15 mm dia threaded nozzle of suitable lengths shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the entire surface prior to concreting of the vertical wall. Similar nozzle are to be also fixed at construction joints, if any, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both the ends to avoid clogging of the nozzles by concrete. Similar nozzles shall also be post fixed at critical points, if required.

The concrete for the vertical wall shall be at least M20 grade as defined by IS:456-1978 having a maximum water cement ratio of 0.45. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete as per the manufacturer's specification. Adequate precaution shall be taken to keep the nozzles horizontal during concreting. The exterior surface of the concrete shall be plastered with 12 mm thick cement sand mortar (1:3) mixed with approved cement waterproofing compound conforming to manufacturer's specification. The plastered surface shall then be finished smooth with a neat coat of cement slurry and painted with two coats of approved solventless resin to form a thick resilient and flexible resinous membrane over the plastered surface.
Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the manufacturer's specification and shall be sealed with a sealing compound as per manufacturer's specification and instruction.

16.0 MISCELLANEOUS

16.1 False ceiling

16.1.1 Scope

This chapter deals with the specification for various types of false ceiling as listed below:

a) Wooden ceiling (solid wood) and decorative ply.
b) Ceiling with insulating Building Board/Particle Boards etc.,
c) A.C. Sheet and ply wood ceiling.
d) Plaster of Paris (Gypsum Anhydrous) ceiling over wooden frame.
e) Plaster of Paris (Gypsum Anhydrous) Tiles ceiling.
f) Wooden cover, fillets, beading for ceiling.

16.1.2 General

16.1.2.1 Materials

All materials shall be in accordance with the general specifications of materials, Part-I, Schedule of items and as shown in drawings.

Special finishing materials as specified in schedule of item shall be procured from the specified source and got fixed by employing skilled worker in the trade under direct supervision of the manufacturer.

16.1.3 Openings for installation of light fittings

Openings in the ceiling for installation of A/C grills, light fittings shall be provided as per drawings.

16.1.4 Recess for pelmet

Recess for the installation of pelmets shall be provided where shown in drawings along the windows/doors.

16.1.5 Grills

Grills made of wooden, M.S., Aluminium, PVC or any other material as necessary shall be provided as indicated in the drawing.

16.1.6 Frame work

The type of frame to receive the ceiling material may be of wood, aluminium or M.S. as specified in the schedule of item and as mentioned in the drawing.
16.1.7 Wooden framing for false ceiling

Unless otherwise specified in schedule of items the wooden frame work shall be of following description:

The frame work for false ceiling shall be of approved quality teak wood scantlings, the runners shall be 75 x 50 mm size and shall be spaced at 1200 mm c/c and the battens shall be 50 x 50 mm size spaced at 600 mm c/c (approx) forming a grid of 600 x 600 mm or any other grid suitable for fixing the false ceiling material and its size. The runner and battens shall be joined by halving joint using counter sunk 6 mm bolt with washer of required length with soffit of runner and batten in perfect level. The heading joints between runners shall be made with lap joints using 2 nos. 6 mm dia counter sunk bolts with washer. Heading lap joints between battens shall be made with suitable size screws. The wall ends of the runner shall be embedded in the wall (50 mm deep) and shall be grouted with 1:2:4 cement concrete. The soffit of framework shall be made perfectly horizontal. The teak wood frames shall be treated with 2 coats of wood preservations treatment before fixing the tiles/boards as the case may be.

The main runners of frames shall be suspended by M.S. flat 40 x 3 mm /12mm dia M.S. round/T.S. hangers placed at 1200 mm c/c (approx), the top end of the hangers shall be hocked to R.C.C. reinforcement of slab or fixed to M.S. flat cleats installed in slab for the purpose or hooked to purlins of the trusses. The hangers may be twisted or ends of M.S. round/T.S. hanger flattened to allow for fixing the same with T.W. frame or M.S. cleats with bolts of suitable size.

For teak wood framings of shaped ceilings the spacings of frames and hangers levels of false ceiling etc., shall be required to obtain the shapes/drops and profile of the ceiling and to the requirement of ceiling material. The frames shall be locally adjusted to create openings of required sizes for installation of light fittings, grills of air conditioning system.

16.1.8 Metal framing

16.1.8.1 Galvanised pressed steel framing system

Galvanised pressed steel framing system for false ceiling shall be procured from reputed manufacturer and installed by specialist agencies under technical guidance of the manufacturer and strictly as per their specifications. Unless specified otherwise these shall consist of G.I. rectangular pipes at 900 mm c/c suspended by M.S. hanger fixed to R.C.C. slab with M.S. cleats and cross channels fixed to rectangular pipes at 450 mm c/c as per “Galvolock” system of M/s Eastern Interior Pvt Limited or equivalent. Ceiling materials shall be fixed to cross channels as per specifications of the manufacturer.

Framing shall be adjusted to provide openings for the light fittings and air-conditioning grills but these shall be supported independently and not on the framing.

16.1.8.2 Aluminium grid ceiling framing system

Framing for Aluminium grid false ceiling system shall be of reputed manufacturer Bestlok, Eezilock or equivalent. It shall consist of aluminium main tee and cross tee's suspended by adjustable hangers fixed to R.C.C. floor with cleats. The grid may be 600 x 600 mm, 1200 x 600 mm or as per drawings. Ceiling materials, shall be fixed to frames strictly as per manufacturers specification.

16.1.9 Fixing of Ceiling

16.1.9.1 Wooden ceiling with planks
These shall be of class of wood and thickness as specified in Schedule of items. Unless specified otherwise the width of the ceiling board shall be 100 mm to 150 mm and shall be planed true on the exposed surface. The maximum length of the finished board shall be 1800 mm. The boards/strips shall be joined with tongue and groove joints and heading joints in adjacent board of the same strip shall be square butt type neatly finished. These joints shall be staggered in alternate strip or line. The boards shall be fixed to T.W. battens by headless brass pins. Moulding beads at junctions with walls and other locations as per drawings shall be provided. Necessary opening for installation of light fittings and A/C grill shall be provided and junctions if required shall be finished with moulded beads.

The false ceiling shall finally be checked for line and level, sand papered and polished with colourless polish to achieve matt satin natural finish.

16.1.9.2 Decorative ply ceiling

These shall be with decorative selected group matched ply of Teak Ply, white cedar ply or any other approved class of veneer ply in strips, square or rectangular panel matching the ply of wall panelling, if any, in the same room and of thickness as per schedule of item and drawings. The strip ply, square/rectangular panels shall be fixed to T.W. framework with panel pins. Moulded beads of same wood as that of ply of matching shade shall be provided at junctions with walls and as specified in drawings.

Where specific pattern of grains and shade is required the ply cut into shapes as per design may be pasted on a backing ply with adhesive and such made panels shall be fixed to framing.

The ceiling shall be checked for line, and levels and exposed surfaces shall be sand papered and finally polished with colourless polish to achieve matt satin natural finish.

16.1.9.3 Ceiling with insulation board/particle boards

Insulation boards shall be of approved manufacturer, shade, design and thickness as specified in schedule of items and drawings. These may be plain, textured, perforated with natural finish or with white finished surface.

The boards shall be cut to suit the panel sizes of ceiling with special tools and by skilled workmen strictly as per manufacturers specifications. The board shall be fixed to T.W. frames with brass screws or as per manufacturers recommendation and in case of metal frames as per recommendations of the manufacturer of the ceiling system. The joints where exposed shall be of uniform thickness (3 mm to 6 mm) and pattern as shown in drawings.

The ceiling shall be checked for line and level and exposed surfaces prepared appropriately to receive the paint as specified in schedule of item and drawing.

16.2. Wooden partitions

16.2.1 Scope

All materials for the wooden partitions shall be of respective class as specified in the part (I) and as mentioned in schedule of items.

16.2.1.2 Frame work

Unless otherwise specified in the schedule of items, framing for partitions shall be made of approved quality teak wood scantlings of sizes as mentioned in schedule of items and
drawing. The spacing of frames shall not exceed 1200 mm c/c in both direction. The joints of the frame shall be made as per standard joinery practice using standard adhesive as described in wood work chapter. The faces of the frames to receive ply/wooden board shall be true to line, level and plumb. The frames shall be firmly secured to walls, ceilings, floors by making chases and grouting the frames in 1:2:4 cement concrete or fixing the frames with metal clamps/flats screwed to above elements. The frame shall be treated with 2 coats of wood preservative. Where the panelling material is of decorative ply of 3.5 mm to 4 mm thickness, commercial ply of 6 mm thickness shall be fixed to the frame work for backing purpose. Where sunk (coffered) panels are to be made, combination of single and double layers ply shall be used for backing to achieve level difference for sunk panels.

16.2.3 Boarding/facing for partition

a) Wooden plank/board

These shall be of class of wood and thickness as specified in the schedule of item and drawings. These shall be fixed to backing wooden frame work with counter sunk brass screws in pattern and designs, with groves, joints, beads, fillets, cover moulds as shown in drawings. The exposed surfaces shall be sand papered and polished as specified.

b) Decorative ply wood facing

These shall be with decorative teak wood/rose ply/white cedar 3.5 to 4 mm thickness of selected pieces with matching colour, texture and grains and shall be fixed to the backing ply with panel pins in pattern, design, with uniform width of joints, beads, fillets, cover mould as shown in drawings. The exposed surfaces shall be lightly sand papered finished with colourless polish to achieve matt satin finish.

c) Jolly pan (laminated) board

Where specified Jolly pan boards shall be fixed to teak wood frame work strictly as per manufacturer’s specification. The boards after fixing shall be cleaned of all adhesives etc.

d) Formica facing

Formica facing shall be fixed to the backing ply with standard adhesive as described for panelling works.

16.3 Expansion and Isolation Joints

16.3.1 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved-laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval, for the method of forming the joints, should be obtained from the Engineer before starting the work.
16.3.2 Bitumen impregnated board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 (Part 1)-1983 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

16.3.3 Joint sealing strips

16.3.3.1 General

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water. The sealing strips will be either metallic like G.I., Aluminium or Copper, or Non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

16.3.3.2 Metal sealing strips

Metal sealing strips shall be either G.I. or Aluminium or Copper and formed straight, U-shaped, Z-shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux. In case it is found that the joints cannot be made leak proof, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor without any additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The Strips shall be strong, durable, without any rust or crease. At the joints, the overlapping should be for a minimum length of 50mm

b) Aluminium strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS : 737-1986. A minimum lap of 50 mm length is required at the joints.

c) Copper strips

The copper strips shall be minimum 18 SWG in thickness and 300 mm width.

It should be cleaned thoroughly before use so as to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.
16.3.3.3 Non-metallic sealing strips

These will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features:

a) Plain
b) Central bulb
c) Dumb-bell or flattened ends
d) Ribbed and corrugated wings
e) V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The actual size and shape shall be as shown in drawings/Schedule of Items and or as directed by the Engineer.

The method of forming these joints, laps etc., shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber sealing strips

The minimum thickness of rubber sealing strips shall be 3 mm and the minimum width 100 mm. The material will be natural rubber and be resistant to corrosion, abrasion and attacks from the acids, alkalies and chemicals normally encountered in service. The physical properties will be generally as follows:

- Specific Gravity: 1.1 to 1.15
- Shore Hardness: 65A to 75A
- Tensile Strength: 25 - 30 N/mm²
- Maximum Safe Continuous Temperature: 75 Degree ‘C’
- Ultimate Elongation: Not less than 350%

b) P.V.C. sealing strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows:

- Specific Gravity: 1.3 to 1.35
- Shore Hardness: 60A to 80A
- Tensile Strength: 10 - 15 N/mm²
- Maximum Safe Continuous Temperature: 70 Degree ‘C’
- Ultimate Elongation: Not less than 275%
16.3.4 Bitumen compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834-1984.

16.4 Barbed Wire Fencing

16.4.1 Materials

16.4.1.1 Galvanised barbed wire

Barbed wire shall be properly galvanised and shall be obtained from the approved manufacturer as specified in detail in Part-1.

16.4.1.2 Other materials

The specifications of materials, for angle iron posts, concrete works, plasters, if any, and for other works, shall conform to the requirements as specified in Part-I.

16.4.2 Workmanship

The work shall comprise of the following:

a) Excavation in ground of required dimensions with all sides vertical in any type of soil including soft rock and removing the soil and dressing it neatly.

b) Filling the holes in full with cement concrete 1:3:6 mix, well packed, after erecting the posts in correct line, level and plumb. In case of any post coming at local depression, the hole may not be of full depth but the depth of concrete will always be made 60 cm raising it above ground level with necessary shuttering.

c) Where the angle iron posts are specified in the item these shall be 50 mm x 75 mm x 6 mm unless mentioned otherwise. 10 mm dia holes with saw cuts for inserting the wires shall be made as per the spacings of barbed wire shown in drawing or as directed by the Engineer. The foot of the post shall be provided with base plate for anchorage. The spacing shall be 2.5 m or as per drawing. After inserting the wire into holes the socket is to be pressed back.

d) Straining bolts are to be provided 15 m apart from each row of wire for maintaining proper tension in the wire and without any sag or looseness.

e) Posts are to be painted as directed by the Engineer.

16.5 Chain link fencing

16.5.1 Scope

The work under this specification covers the supply and fixing of galvanised steel chain link fencing with galvanised steel posts chain link fabric.

16.5.2 Material
Galvanised steel chain link fabric and galvanised steel pipe posts shall be obtained from the approved manufacturer as specified in detail in Part - I.

16.5.3 Workmanship

The GI pipe posts shall be embedded in plain cement concrete not leaner than 1:4:8 foundations. The height of posts above top of foundations and spacing of post shall not be more than 3 m. The chain link fabric shall be fixed to the fencing posts with the help of stretcher galvanised bars (25 x 6 flats) which will be bolted to the lugs welded to the posts. The stretcher bars shall be provided in the lapping of fabric also.
SPECIFICATION FOR FLY ASH -CEMENT BRICKS

1.1 Scope

This section covers the setting up of a manufacturing plant for fly ash – cement bricks as per the directions of the Owner. This section also includes transportation of raw materials storage and proportioning of raw materials, handling and mixing of raw materials, manufacturing of bricks, curing, handling and laying of bricks and conducting quality control tests.

1.2 Unless specifically mentioned otherwise, all applicable codes and standards published by the Bureau of Indian Standards shall govern design, workmanship, quality and properties of materials, method of field and laboratory testing, method of measurement for different items of work etc.

1.3 Materials

1.3.1 Cement : 33 grade ordinary Portland cement conforming to IS:269 or Higher Grade above 33 Grade.

1.3.2 Sand : Sand shall be free from deleterious materials like clay and silt in sand and shall be less than 5%. Sand shall conform to IS: 383.

1.3.3 Fly Ash : Fly ash used for manufacturing fly ash cement bricks shall conform to Grade-I or Grade-2 of IS:3812. Fly ash will be available near the Electro static precipitators / fly ash storage silos/at a place indicated by Purchaser inside plant area

1.4 Collection of fly ash

The contractor has to make his own arrangements for collecting the fly ash from the fly ash storage silos or other designated area inside the captive power plant through covered trucks and transporting them to work site. Fly ash will be transferred in the covered trucks by flexible chute. No extra charges will be paid for collecting the fly ash from silos inside the captive power plant and transporting them casting yard. Fly ash is supplied free of cost at the discharge point of silos.

1.5 Fist Aid Treatment

Necessary first aid treatment shall be made available at site by the contractor.

1.6 Storage of Raw Materials

1.6.1 Cement

1.6.1.1 The cement used shall be as specified in Clause No. 1.3.1. The contractor shall carry out the required tests at his own cost in an approved testing laboratory and submit the test report for the approval of the Engineer before using the cement in the works.
1.6.1.2  Cement shall be stored on raised platforms inside stores covered on all sides and roof with provision for ample ventilation. More than ten (10) bags of cement shall not be stacked one above the other in the stack. Sufficient space shall be left around the stacks for approach. Stacking shall be so arranged that bags from the oldest consignment can be conveniently removed first for use following the principle of first in first out (FIFO) basis. For the proper label tag indicating date of supply shall be displayed over the stack of stored cement received that a consignment (Batch) cement which has hardened, clodded or deteriorated due to over stacking or long storage shall not be used in the works and shall be removed from the site immediately with instruction to Employer and Engineer-in-charge.

1.6.1.3  For ensuring better quality of fly ash bricks the contractors shall offer to Employer / Engineer-in-charge for checking the lot No. / Grade of cement etc. before unloading the same in their store. The contractor shall also furnish the daily consumption of cement, fly ash bricks manufactured and balance cement available in their store on day-to-day basis. The contractor shall offer for checking the storage of cement as and when required by Employer / Engineer-in-charge.

1.6.2  Sand (Fine aggregate)

Sand shall conform to IS: 383 and shall be river or pit sand. Sand shall be spread at site on clean and hard base or in compartments. Samples of sand to be used shall be submitted to the Engineer-in-charge for approval before commencement of work. The contractor shall ensure that over the entire period of construction all consignments of sand brought to the site conforms to the quality and grading as approved by the Engineer-in-charge before the commencement of work. Whenever directed by the Engineer-in-charge the contractor shall perform tests at his own cost to satisfy that the grading and quality approved for sand is being maintained. Sampling of aggregate shall conform to IS:2430 and tests shall conform to IS: 2386. The percentage to flaky and elongated pieces should not exceed 15%.

1.6.3  Fly Ash

Fly ash being a very fine material gets air borne easily and causes dust nuisance. It may also lead to environmental pollution. The fly ash may require on site temporary stock piling if the rate at which the ash is transported to the fly ash brick manufacturing site is more than the demand for an efficient rate of placement. Such cases should be avoided to the extent possible and in case stock piling at site is inevitable, adequate precautions should be taken to prevent dusting. Otherwise the surface of the fly ash stock pile may be covered with tarpaulins or a thin layer of soil not subject to dusting.

1.7  Proportion

1.7.1  The proportion of raw materials for the fly ash cement bricks is described based on trial mixes carried over at site earlier based on the test certificates.

1.7.2  The proportion of Fly ash, sand and cement shall be as given below:

<table>
<thead>
<tr>
<th>Material</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>8 – 10 %</td>
</tr>
<tr>
<td>Sand (fine aggregate)</td>
<td>35 – 40 %</td>
</tr>
<tr>
<td>Fly ash</td>
<td>50 – 60 %</td>
</tr>
</tbody>
</table>
1.7.3 The fly ash bricks manufactured shall meet the testing and acceptance criteria specified in Clause 1.13.

1.8 Moulds

The moulds shall be made of metal and true to shape and dimensions of the finished product as indicated in the drawings. The moulds shall be close jointed and perfectly smooth with joints caulked to prevent leakage of fly ash mixture slurry. The moulds shall be of rigid construction to prevent distortion and bulging of sides and base. The moulds shall be designed with suitable fastenings to allow them to be struck without injury to the casting. The mould must be made to carry a frog of appropriate size with “RSP” marked on it.

1.9 Mixing

The raw materials shall be weigh batched and uniformly and properly blended in pan mixer for about 3 to 5 minutes with required quantity of water. If the mixture contains lumps, the mixing time shall be increased.

1.10 Manufacturing

Fly ash, sand and cement shall be mixed in proportion as per Cl. No. 1.7 Cement, Sand and Fly ash are added into the pan mixture with optimum water to form a homogeneous mixture uniform in color and then transferred to the moulding machine. In the moulding machine, the mixture is hydraulically pressed or compacted through vibratory press and removed carefully from moulds. After the removal of bricks from the mould, they are air dried for 3 days.

1.11 Marking

All pre-cast bricks shall be marked in a manner approved by the Engineer-in-charge in a conspicuous place with date of manufacture and marking number. The upper part of the bricks shall be marked distinctly to ensure proper handling.

1.12 Curing

The contractor shall keep all the bricks wet for not less than 28 days.

1.13 Testing & Acceptance criteria

1.13.1 Sampling and criteria for conformity

Sampling and criteria for conformity of the bricks shall be as given in IS: 5454.

1.13.2 Compressive strength

Minimum compressive strength of fly ash bricks shall be as specified in IS:12894 when tested as per IS:3495 (Part-1) of class 10, as specified in sub clause No. 6.1 page 02.

1.13.3 Drying shrinkage

The average drying shrinkage of three units shall not exceed 0.15% when tested by the method described in IS:4139.

1.13.4 Efflorescence
The bricks shall be tested as per IS:3495 (Part-3) and shall have the rating of efflorescence not more than moderate.

1.13.5 Water absorption

The bricks, when tested in accordance with the procedure laid down in IS:3495 (Part-2) after immersion in cold water for 24 hours, shall have average water absorption not more than 20% by mass.

1.14 Laboratory

The rate of raw materials and quality of bricks shall be tested in the presence of Engineer-in-charge in the approved laboratory with above testing facilities.

1.15 Transportation of fly ash bricks

The contractor has to make his own arrangement for transporting the cured bricks at no extra cost from casting yard to working place.
SPECIFICATION FOR CIVIL WORKS

PART – III NORMS OF CEMENT CONSUMPTION
CONTENTS

1. MASONRY WORK  .................................................. 2
2. PLAIN/REINFORCED CONCRETE WORK  .................... 2
3. FINISHING WORK ..................................................... 3
4. FLOORING WORK ..................................................... 4
5. MISCELLANEONS ITEMS ............................................ 8
6. WATER SUPPLY/DRAINAGE & SANITARY WORKS .... 10
GENERAL

For calculating the requirements of cement in various items of work the following standards will be adopted. Over the above theoretical quantity of cement, additional allowance upto plus or minus 3% shall also be allowed as certified by the engineer.

For items not covered in this standard, CPWD standards shall be followed or calculated as per uses/requirement in absence of standard norms. Cement required for enabling work and cement required for testing purposes will be taken into account for consumption purpose. However, in no case such quantity should exceed 5% of the total cement used in the work or as certified by the engineer based on actual observation whichever is less.
**MASONRY WORK**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description of Item</th>
<th>Cement Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Random rubble masonry with CM 1:4</td>
<td>1.255 quintals per cum</td>
</tr>
<tr>
<td>2.</td>
<td>Random rubble masonry with CM 1:6</td>
<td>0.825 quintal per cum</td>
</tr>
<tr>
<td>3.</td>
<td>Coursed rubble masonry in CM 1:6</td>
<td>0.75 quintal per cum</td>
</tr>
<tr>
<td>4.</td>
<td>Brick work in CM 1:4</td>
<td>0.950 quintal per cum of BW</td>
</tr>
<tr>
<td>5.</td>
<td>Brick work in CM 1:6</td>
<td>0.625 quintal per cum of BW</td>
</tr>
<tr>
<td>6.</td>
<td>Half brick work in CM 1:3</td>
<td>1.43 quintals per 10 sqm of area</td>
</tr>
<tr>
<td>7.</td>
<td>Half brick work in CM 1:4</td>
<td>1.06 quintals per 10 sqm of area</td>
</tr>
<tr>
<td>8.</td>
<td>75mm thick brick in CM 1:4</td>
<td>0.65 quintal per 10 sqm of area</td>
</tr>
<tr>
<td>9.</td>
<td>75mm thick brick in CM 1:3</td>
<td>0.81 quintal per 10 sqm of area</td>
</tr>
<tr>
<td>10.</td>
<td>Projected brick bands, Drip course etc. in CM 1:6 finished with 12mm thick cement plaster</td>
<td>0.165 quintal per 10 RM</td>
</tr>
<tr>
<td>11.</td>
<td>Half brick thick, Honey combed brick work in CM 1:4</td>
<td>0.064 quintals per sqm</td>
</tr>
</tbody>
</table>

**PLAIN/REINFORCED CONCRETE**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description of Item</th>
<th>Cement Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>RCC/PCC of nominal mix 1:5:10 complete (excluding finishing with CP)</td>
<td>1.30 quintals per cum of concrete</td>
</tr>
<tr>
<td>2.</td>
<td>RCC/PCC of nominal mix 1:4:8 complete (excluding finishing with CP)</td>
<td>1.70 quintals per cum of concrete</td>
</tr>
<tr>
<td>3.</td>
<td>RCC/PCC of nominal mix 1:3:6 complete (excluding finishing with CP)</td>
<td>2.23 quintals per cum of concrete</td>
</tr>
<tr>
<td>4.</td>
<td>RCC/PCC of nominal mix 1:2:4 complete (excluding finishing with CP)</td>
<td>3.18 quintals per cum of concrete</td>
</tr>
<tr>
<td>5.</td>
<td>RCC/PCC of nominal mix 1:1.5:3 complete (excluding finishing with CP)</td>
<td>4.00 quintals per cum of concrete</td>
</tr>
<tr>
<td>6.</td>
<td>RCC/PCC of nominal mix 1:1:2 complete (excluding finishing with CP)</td>
<td>6.10 quintals per cum of concrete</td>
</tr>
</tbody>
</table>

**Controlled Concrete - Plain and Reinforced**
7. Concrete grade
   (i) M -5A
   (ii) M -5B
   (iii) M -7.5A
   (iv) M -7.5B

8. Concrete grade
   (i) M -10A
   (ii) M -10B
   (iii) M -10C

   To be mutually agreed based on
   mix design to be prepared by
   contractor & approved by the
   Engineer

9. Concrete grade
   (i) M -15B
   (ii) M -15C
   (iii) M -15D

   plus
   wastage and all incidentals as
   decided.

10. Concrete grade
    (i) M -20B
    (ii) M -20C
    (iii) M -20D

11. Concrete grade
    (i) M -25B
    (ii) M -25C
    (iii) M -25D

12. Concrete grade
    (i) M -30C
    (ii) M -30D

13. Applying cement slurry on
    RCC slab for receiving
    cement concrete flooring.

    2.75 kg/sqm

FINISHING

1. 6mm thick C.P. 1:4  0.280 quintal per  10 sqm area
2. 10mm thick C.P. 1:5  0.370 quintal per  10 sqm area
3. 10mm thick C.P. 1:4  0.430 quintal per  10 sqm area
4. 10mm thick C.P. 1:6  0.300 quintal per  10 sqm area
5. 12mm thick C.P. 1:3  0.734 quintal per  10 sqm area
6. 12mm thick C.P. 1:4  0.547 quintal per  10 sqm area
7. 12mm thick C.P. 1:6  0.360 quintal per  10 sqm area
8. 15mm thick C.P. 1:4  0.655 quintal per  10 sqm area
9. 15mm thick C.P. 1:6  0.440 quintal per  10 sqm area
10. 20mm thick C.P. 1:4  0.850 quintal per  10 sqm area
11. 20mm thick C.P. 1:6  0.560 quintal per  10 sqm area
12. 12mm thick bearing plaster in
    CM 1:4 with neat cement finish
    0.590 quintal per  10 sqm area
13. Neat cement punning  0.200 quintal per  10 sqm area
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Quantity per 10 sqm area</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.</td>
<td>Flush or ruled or cut or weather pointing on brick work with CM 1:3</td>
<td>0.155 quintal</td>
</tr>
<tr>
<td>15.</td>
<td>Flush or ruled or cut out or weather pointing on brick work with CM 1:2</td>
<td>0.200 quintal</td>
</tr>
<tr>
<td>16.</td>
<td>Raised and cut pointing on brick work with cement mortar 1:3</td>
<td>0.235 quintal</td>
</tr>
<tr>
<td>17.</td>
<td>Flush or ruled pointing on brick flooring with cement mortar 1:4</td>
<td>0.075 quintal</td>
</tr>
<tr>
<td>18.</td>
<td>Flush or ruled pointing on brick flooring with cement mortar 1:6</td>
<td>0.050 quintal</td>
</tr>
</tbody>
</table>

**FLOORING**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Quantity per 10 sqm area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Brick on edge flooring in cement mortar 1:4</td>
<td>1.100 quintal</td>
</tr>
<tr>
<td>2.</td>
<td>Brick on edge flooring in cement mortar 1:6</td>
<td>0.800 quintal</td>
</tr>
<tr>
<td>3.</td>
<td>25mm thick (IPS) cement concrete flooring 1:2:4 (1 cement : 2 sand : 4 graded stone chips 12mm nominal size) finished with a floating coat of neat cement.</td>
<td>1.020 quintal</td>
</tr>
<tr>
<td>4.</td>
<td>40mm thick (IPS) cement concrete flooring 1:2:4 with 20mm and down stone chips finished with a floating coat of neat cement.</td>
<td>1.500 quintal</td>
</tr>
<tr>
<td>5.</td>
<td>25mm thick (IPS) flooring with base coat 19mm thick 1:2:4 using stone chips 10mm nominal size and 6mm topping coat 1:1 (1 cement : 1 stone chips 3mm size ) with a floating coat of neat cement.</td>
<td>1.370 quintal</td>
</tr>
<tr>
<td>6.</td>
<td>40mm thick (IPS) flooring with base coat 30mm thick 1:2:4 using stone chips 10mm nominal size and10mm topping coat 1:1 (1 cement : 1 stone chips 3 to 6mm size) with a floating coat of neat cement.</td>
<td>2.320 quintal</td>
</tr>
<tr>
<td>7.</td>
<td>25mm thick cast-in-situ grey terrazzo flooring, under layer 19mm thick cement concrete 1:2:4 with 10mm nominal size chips and 6mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.</td>
<td>1.370 quintal</td>
</tr>
<tr>
<td>8.</td>
<td>40mm thick cast-in-situ grey terrazzo flooring, under layer 30mm thick cement concrete 1:2:4</td>
<td>1.370 quintal</td>
</tr>
</tbody>
</table>
with 10mm nominal size chips and 10mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.

9. 40mm thick cast-in-situ terrazzo flooring, under layer 31mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 9mm thick with marble chips of size 4 to 7mm nominal size laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.
   a) Dark or light shade pigment with grey cement
   b) Light shade pigment or without any (grey cement) pigment with white cement
   c) Medium shade pigment with 50% grey cement and 50% white cement

10. 40mm thick cast-in-situ terrazzo flooring, under layer 28mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 12mm thick with marble chips of size 7 to 12mm nominal size laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 2:3 (2 cement marble powder mix : 3 marble chips) by volume.
   a) Dark or light shade pigment with grey cement
   b) Light shade pigment or without any (grey cement) pigment with white cement
   c) Medium shade pigment with 50% grey cement and 50% white cement
   d) White cement without any pigment

11. Terrazzo cast-in-situ skirting and dado, top layer 6mm thick marble chips laid in cement marble powder mix 3:1 (3 cement : 1 marble
powder) by weight in proportion of 4:7 (4 cement marble : 7 marble chips) by volume.

(A) 18mm thick with under layer 12mm thick cement plaster 1:3

<table>
<thead>
<tr>
<th>Description</th>
<th>Grey Cement</th>
<th>White Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Dark or light shade pigment with grey cement</td>
<td>1.490 quintal</td>
<td>0.400 quintal</td>
</tr>
<tr>
<td>b) Light shade pigment or without any pigment with white cement.</td>
<td>1.090 quintal (grey cement)</td>
<td>0.200 quintal (white cement)</td>
</tr>
<tr>
<td>c) Medium shade pigment with 50% grey cement and 50% white cement</td>
<td>1.290 quintal (grey cement)</td>
<td>0.200 quintal (white cement)</td>
</tr>
</tbody>
</table>

(B) 21mm thick, with under layer 15mm thick cement plaster 1:3

<table>
<thead>
<tr>
<th>Description</th>
<th>Grey Cement</th>
<th>White Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Dark or light shade pigment with grey cement</td>
<td>1.640 quintal</td>
<td>0.400 quintal</td>
</tr>
<tr>
<td>b) Light shade pigment or without any pigment with white cement.</td>
<td>1.230 quintal (grey cement)</td>
<td>0.200 quintal (white cement)</td>
</tr>
<tr>
<td>c) Medium shade pigment with 50% grey cement and 50% white cement</td>
<td>1.430 quintal (grey cement)</td>
<td>0.200 quintal (white cement)</td>
</tr>
</tbody>
</table>

12. Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm laid in 25mm thick bed of lime mortar, jointed with neat cement slurry mixed with pigment

<table>
<thead>
<tr>
<th>Description</th>
<th>Grey Cement</th>
<th>White Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Dark shades using grey cement</td>
<td>0.88 quintal</td>
<td>0.44 quintal</td>
</tr>
<tr>
<td>b) Light shade using white cement.</td>
<td>0.44 quintal (grey cement)</td>
<td>0.22 quintal (white cement)</td>
</tr>
<tr>
<td>c) Medium shade using 50% grey cement and 50% white cement</td>
<td>0.66 quintal (grey cement)</td>
<td>0.22 quintal (white cement)</td>
</tr>
</tbody>
</table>

13. Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm in skirting or on walls, laid on 12mm thick cement plaster 1:3 jointed with neat cement slurry

<table>
<thead>
<tr>
<th>Description</th>
<th>Grey Cement</th>
<th>White Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Dark shades using grey cement</td>
<td>1.395 quintal</td>
<td>0.44 quintal</td>
</tr>
</tbody>
</table>
b) Light shade using white cement.
   1.175 quintal per (grey cement)
   0.22 quintal per (white cement)
   10 sqm area

10 sqm area

c) Medium shade using 50% grey cement and 50% white cement
   1.285 quintal per (grey cement)
   0.11 quintal per (white cement)
   10 sqm area

10 sqm area

14. White glazed tiles 5, 6 or 7 mm thick in flooring, skirting and dado on 12 mm thick cement plaster 1 : 3 in base and joined with white cement, slurry etc.
   0.942 quintal per (grey cement)
   0.25 quintal per (white cement)
   10 sqm area

10 sqm area

15. Marble stone slab flooring over 20mm thick base of lime mortar 1:1:1 (1 lime : 1 surkhi : 1 sand) and jointed with white cement slurry etc.
   a) 20 mm thick / 30 mm thick / 40 mm thick
   0.075 quintal per (white cement)
   10 sqm area

10 sqm area

16. Marble stone slab flooring over 20mm thick base of cement mortar 1:4 & jointed with white cement slurry etc.
   a) 20 mm thick
   1.275 quintal per (grey cement)
   0.075 quintal per (white cement)
   10 sqm area

10 sqm area

b) 30 mm thick
   1.290 quintal per (grey cement)
   0.075 quintal per (white cement)
   10 sqm area

10 sqm area

c) 40 mm thick
   1.310 quintal per (grey cement)
   0.075 quintal per (white cement)
   10 sqm area

10 sqm area

17. Marble tiles 18 to 24 mm thick in risers of steps, skirting, dado, walls and pillars laid on 12mm thick cement mortar 1:3 (1 cement : 3 sand ) and jointed with white cement slurry
   1.16 quintal per (grey cement)
   0.075 quintal per (white cement)
   10 sqm area

10 sqm area

18. Extra for each additional thickness of 5 mm granolithic layer of 1:2:4 for flooring
   0.016 quintal per 10 sqm of area

12mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.
20. 15mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.  
   0.800 quintal per 10 sqm of area

21. 19mm thick cement plaster skirting and dado with 12mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.  
   0.995 quintal per 10 sqm of area

22. 25mm thick cement plaster skirting and dado with 18mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.  
   1.35 quintal per 10 sqm of area

MISCELLANEOUS

1. Marble work for wall lining (Veneer work) 1.8 to 2.4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust)  
   0.715 quintal per 10 sqm of area (grey cement)  
   0.170 quintal per 10 sqm of area (white cement)

2. Marble work for wall lining (Veneer work) 4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust)  
   1.020 quintal per 10 sqm of area (grey cement)  
   0.170 quintal per 10 sqm of area (white cement)

3. Grading roof for water proofing treatment with:
   a) CC 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size)  
      3.2 quintal per cum of Concrete
   b) CM 1:3  
      5.1 quintal per cum of mortar
   c) CM 1:4  
      3.8 quintal per cum of mortar

4. Providing and fixing MS fan clamps of standard shape and size in existing RCC slab including cutting chase and making good.  
   0.016 quintal each

5. Making plinth protection 50mm thick of CC 1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 20mm nominal size) over 75mm bed of dry brick ballast 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth.  
   1.1 quintal per 10 sqm of area
6. Grouting with
   a) CM 1:2 7.18 quintal per cum
   b) CM 1:3 5.40 quintal per cum
7. DPC 25mm thick (1:2:4) 0.81 quintal per 10 sqm of area
8. Making plinth protection with bricks on edge in CM 1:6 over 7.5cm bed of dry brick aggregate 40mm nominal size rammed, consolidated and grouted with fine sand and top of bricks pointed with CM 1:2. 0.86 quintal per 10 sqm of area
9. Providing and fixing 25mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls. 0.05 quintal per 10 RM
10. Providing and fixing 40mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls. 0.075 quintal per 10 RM
11. Providing chases 75mm wide 50mm deep in walls for conduit pipe and filling the same with CC 1:3:6 0.075 quintal per 10 RM
12. Fixing steel windows with 1:2:4 concrete blocks 0.40 quintal per 10 sqm of area
13. Cement-sand mortar :
   a) 1:1(1cement :1sand) 10.2 quintals per cum
   b) 1:2(1cement : 2sand) 6.8 quintals per cum
   c) 1:3(1cement : 3sand) 5.1 quintals per cum
   d) 1:4(1cement : 4sand) 3.8 quintals per cum
   e) 1:5(1cement : 5sand) 3.1 quintals per cum
   f) 1:6(1cement : 6sand) 2.5 quintals per cum

DRAINAGE/SANITARY & WATER SUPPLY INSTALLATIONS
1. 100mm dia AC rain water pipe l/c fittings with CM 1:2 0.725 quintal per 100 RM of pipe
2. 150mm dia AC rain water pipe l/c fittings with CM 1:2 0.82 quintal per 100 RM of pipe
3. Fixing IWC pan with traps, pair of footrests, and flushing cistern complete 0.125 quintal each
4. Fixing EWC pan with trap and flushing cistern complete 0.01 quintal each
5. Fixing wash basin and kitchen sink 0.025 quintal each
6. Fixing urinal cistern including pipes 0.025 quintal each
7. Fixing & finishing floor trap 0.015 quintal each
8. Fixing HCl pipes and specials, 100mm dia and 75mm dia including making good the walls 0.135 quintal per 10 RM of pipe
9. Fixing GI pipes of all dia with clamps (for inside work only) 0.015 quintal per 10 RM of pipe
10. Jointing glazed stoneware pipe with CM 1:1
   a) 100 mm dia 2.17 quintals per 10 RM of pipe
   b) 150 mm dia 3.23 quintals per 10 RM of pipe
11. Laying cement concrete 1:5:10 all round SW pipe including bed concrete as per standard design
    a) 100mm dia SW pipe 19.24 quintals per 100 RM of pipe
    b) 150mm dia SW pipe 23.53 quintals per 100 RM of pipe
12. Gully chamber as per specification 0.385 quintal each
13. Stopcock chamber as per specification 0.185 quintal each
14. Inspection chambers as per specification
    a) 600x600x600mm deep 1.43 quintals each
    b) 750x600x600mm deep 1.435 quintals each
    c) 900x900x600mm deep 1.885 quintals each
15. Extra depth of inspection chambers as per specification
    a) 600x600mm 0.805 quintal per RM of depth
    b) 750x600mm 1.295 quintal per RM of depth
    c) 900x900mm 1.460 quintal per RM of depth
d) 1200x900mm 1.835 quintal per RM of depth
SPECIFICATION FOR CIVIL WORKS

PART – IV DIMENSIONAL TOLERANCE
GENERAL

The materials used in construction shall, besides conforming to the specifications and standards mentioned, be the best of the existing kinds obtainable. Where a particular 'Brand' or 'Make' of material is specified such 'Brand' or 'Make' of material alone shall be used.

A high standard of workmanship and accuracy shall be achieved in all sections and parts of the work. The workmanship shall be in accordance with the latest and the best civil engineering practice.

The Contractor shall ensure that all sections of the work are carried out with utmost care to achieve the dimensions shown in drawings or specifications. Where special and close tolerances are required in any particular section of work, these will be shown in the drawing and such tolerances shall be met. In the absence of such specific mention in drawings the following dimensional deviations may be tolerated, provided they do not impair the appearance or render the particular section of work unacceptable to the purpose for which it is intended. Tolerance for materials and workmanship not covered in this part as mentioned hereinafter will be in accordance with the relevant IS code.

<table>
<thead>
<tr>
<th>Description</th>
<th>Permissible tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building bricks, in length width and height</td>
<td>As per IS 1077 - 1992</td>
</tr>
<tr>
<td>Laterite stone, in length, width &amp; height</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>Natural building stone</td>
<td></td>
</tr>
<tr>
<td>a) For stones required in ashlar masonry</td>
<td></td>
</tr>
<tr>
<td>Length &amp; Breadth</td>
<td>Plus or minus 5mm</td>
</tr>
<tr>
<td>Height</td>
<td>Plus or minus 3mm</td>
</tr>
<tr>
<td>b) For stones required other than in ashlar masonry</td>
<td></td>
</tr>
<tr>
<td>Length &amp; Breadth</td>
<td>Plus 5mm, minus 10mm</td>
</tr>
<tr>
<td>Height</td>
<td>Plus 5mm, minus 5mm</td>
</tr>
<tr>
<td>Concrete and reinforced concrete pipes : Length</td>
<td>Plus or minus 1% of standard length</td>
</tr>
<tr>
<td>Internal diameter, upto 300 mm</td>
<td>Plus 3 mm Minus 1.5 mm</td>
</tr>
<tr>
<td>Cast iron spigot &amp; socket pipes and fittings</td>
<td></td>
</tr>
<tr>
<td>Length of fittings</td>
<td>Plus or minus 10mm</td>
</tr>
<tr>
<td>Length of pipe</td>
<td>Plus or minus 20mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>minus 1 mm</td>
</tr>
<tr>
<td>Internal dia of socket</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td>Depth of socket</td>
<td>Plus or minus 10mm</td>
</tr>
<tr>
<td>External dia, upto 75 mm</td>
<td>Plus or minus 3mm</td>
</tr>
<tr>
<td>Description</td>
<td>Permissible tolerance</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>100 mm</td>
<td>Plus or minus 3.5mm</td>
</tr>
<tr>
<td>150 mm</td>
<td>Plus or minus 4mm</td>
</tr>
<tr>
<td><strong>Stoneware pipes, in length</strong></td>
<td></td>
</tr>
<tr>
<td>upto 75 cm</td>
<td>Plus or minus 10mm</td>
</tr>
<tr>
<td>Upto 90 cm</td>
<td>Plus or minus 15mm</td>
</tr>
<tr>
<td>In thickness of barrel and socket not exceeding 450mm</td>
<td>Plus or minus 2mm</td>
</tr>
<tr>
<td>In thickness of barrel and socket between 500 to 600mm</td>
<td>Plus or minus 3mm</td>
</tr>
<tr>
<td>Glazed tiles, length of all 4 sides</td>
<td>Plus or minus 0.8mm</td>
</tr>
<tr>
<td>Individual dimensions and thickness</td>
<td>Plus or minus 0.5 mm</td>
</tr>
<tr>
<td>Metal doors, windows and ventilators - In overall</td>
<td></td>
</tr>
<tr>
<td>dimension</td>
<td>Plus or minus 1.5 mm</td>
</tr>
<tr>
<td>Wooden doors, windows, ventilators Overall dimension</td>
<td></td>
</tr>
<tr>
<td>of door, window, ventilators</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td>All components of shutter except glazing bar Width</td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td></td>
<td>Plus or minus 1 mm</td>
</tr>
<tr>
<td>Glazing bar, width &amp; thickness</td>
<td>Plus or minus 1 mm</td>
</tr>
</tbody>
</table>

**Mild steel tubes, tubulars and other wrought steel fittings**

a) Thickness
   i) butt welded light tubes : Plus not limited minus 8%
   medium and heavy tubes : plus not limited minus 10%
   ii) seamless tubes : plus not limited minus 12.5%

b) Weight
   i) single tube (irrespective of the quantity) : + 10%, - 8%
   ii) for quantity of less than 150m of one size : + 10%, - 8%
   iii) for quantity of 150m and over of one size : + 4%, - 4%

**Earth work**
Finished level of site levelling in hard rock : Plus or minus 50mm

Finished level of site levelling except for hard rock : Plus or minus 100 mm

Level of pits, trenches foundations : Plus or minus 50mm

**Concrete & Reinforced concrete**

Footings, plan dimension : Plus 50 mm Minus 12 mm

Eccentricity : 0.02 times the dimension of footing in the direction limited to 50 mm

Thickness : Plus or minus 0.05 times the specified thickness

Foundations

Deviation of planes and lines of their intersection from vertical or inclination along full height : Plus or minus 20 mm

Deviation of horizontal plane from horizontal line for 1 m of the plane in any direction : Plus or minus 5mm

for the whole plane : Plus or minus 20mm

Sizes of cross section : Plus or minus 8mm

Surfaces of inserts to support loads : Plus or minus 5mm

Length of elements : Plus or minus 20 mm

**Equipment foundations :**

Top level of bolt : Plus 20mm

Top level of foundation before grouting : Minus 20mm

Axes of anchor bolts in plan : Plus or minus 5mm

Axis of foundation in either direction : Plus or minus 10mm

Deviation in vertical line along height : Plus or minus 10mm

Sizes of pits in plan : Plus or minus 20 mm

Sizes of steps in plan : minus 20mm

Levels of steps, benches and pits : minus 20mm
Axes of inserts in plan : Plus or minus 10 mm

Basic dimensions in plan : Plus or minus 10 mm

Deviation of horizontal plan from horizontal line
for 1 m of plane in any direction : Plus or minus 5 mm
for the whole plane : Plus or minus 20 mm

Local deviations of top surface when checked with a 2 m long straight edge : Plus or minus 8 mm

**Buildings :**

Surfaces when checked with a 2 m long straight edge : Plus or minus 8 mm

Sizes of cross section : Plus 8 mm Minus 0 mm

Length of elements : Plus or minus 20 mm

Deviation from horizontal plane, for whole building : Plus or minus 10 mm

Plumb in verticality : 1 in 1000 of height
for columns supporting floor beams : Plus or minus 10 mm
for framed columns linked with crane girders and beams : Plus or minus 10 mm

Reinforced concrete walls : Length : Plus or minus 20 mm

Flatness of surface when checked with a 2 m long straight edge : Plus or minus 8 mm

Level of top surface to support assembled elements : Plus or minus 5 mm

Deviation in planes and lines of intersection from vertical : Plus or minus 15 mm

Size of cross section : Plus or minus 8 mm

**Placing of reinforcement :**

Length of bar upto 75 cm long (Other than straight bars) : Plus 3 mm Minus 5 mm

75 - 150 cm long : Plus 5 mm Minus 10 mm

150 - 250 cm long : Plus 6 mm Minus 15 mm
<table>
<thead>
<tr>
<th><strong>General Technical Specification</strong></th>
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<tbody>
<tr>
<td><strong>250 cm long and above</strong></td>
</tr>
<tr>
<td><strong>Straight bars, all lengths</strong></td>
</tr>
<tr>
<td><strong>Spacing of bars</strong></td>
</tr>
</tbody>
</table>

**Anchor bolts :**

| **Shift in location in plan**      | : Plus or minus 5 mm |
| **Same, when bolts are located outside of structural columns** | : Plus or minus 10 mm |
| **Top level**                      | : Plus 20 mm |
| **Threaded length**                | : Plus 30 mm |

<table>
<thead>
<tr>
<th><strong>Masonry</strong></th>
<th><strong>For Walls</strong></th>
<th><strong>For Pillars</strong></th>
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<tr>
<td><strong>Width</strong></td>
<td>Plus or minus 10 mm</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td><strong>Shift in axes</strong></td>
<td>Plus or minus 10 mm</td>
<td>---</td>
</tr>
<tr>
<td><strong>Deviation in row from horizontal line for every 10m length</strong></td>
<td>Plus or minus 15 mm</td>
<td>---</td>
</tr>
<tr>
<td><strong>Flatness of surface when checked with a 2 m long straight edge</strong></td>
<td>Plus or minus 10 mm</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td><strong>Deviation in lines separating storeys Deviation of surface from vertical and at angles and corners</strong></td>
<td>Plus or minus 15 mm</td>
<td>Plus or minus 15 mm</td>
</tr>
<tr>
<td><strong>for 1 storey</strong></td>
<td>Plus or minus 10 mm</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td><strong>for whole building</strong></td>
<td>Plus or minus 30 mm</td>
<td>Plus or minus 30 mm</td>
</tr>
<tr>
<td><strong>Dimensions of openings for doors, windows etc</strong></td>
<td>Plus 15 mm</td>
<td>Minus 0 mm</td>
</tr>
<tr>
<td><strong>Flooring, skirting, dado and plastering</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
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Civil  
Page 5 of 6
Insitu concrete floor : 4 mm

Concrete tile and mosaic, in any 3 m length : 3 mm

in large open area : 15 mm

Wall tiling - surface should not vary from general plane by more than 1 in 200. Marble and such superior work, in any 2 m length : 1.5 mm

in any row : 3 mm

Plastered surfaces, flatness when checked with a 2 m long straight edge : 3 mm

Vertical surfaces, upto 1 storey : 5 mm

Over full heights : 10 mm

Metallic Inserts on assembled components length and width : Plus or minus 3 mm

**Road work**

The levels of the sub-grade and different pavement courses should not vary from those calculated with reference to the longitudinal and cross-sections of the road as shown on the drawing beyond the tolerance given below :-

Sub-grade : plus or minus 25mm

Sub-base : plus or minus 20mm

Base : plus or minus 15mm

Wearing course : plus or minus 6mm
SPECIFICATION FOR CIVIL WORKS

PART – V METHOD OF MEASUREMENT
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1.0 GENERAL

1.1 The method of measurement of the various items of work shall be in accordance with IS : 1200 (Part 1 to 28) - 1971 to 1993 unless otherwise mentioned in this part or in the schedule of items or in preamble or in the specification.

1.2 If there is any contradiction in meaning between any portion of this part and that of IS :1200 (Part 1 to 28) - 1971 to 1993, the stipulation of this part shall prevail.

1.3 The descriptions and explanations given herein have as much forces as though they are incorporated into the description of the items themselves in the schedule of items.

2.0 EARTH WORK & SAND FILLING

2.1 General

2.1.1 Each dimension upto 25 m shall be measured to nearest 0.01 m and to nearest 0.1 m for dimensions over 25 m. Areas shall be worked out to the nearest 0.01 m² and cubical contents to the nearest 0.01 m³.

2.1.2 Shoring and strutting shall not be measured separately unless otherwise specified.

2.1.3 Dewatering for earth work and sand filling work shall not be measured separately unless otherwise specified.

2.1.4 For classification of soils, relevant clauses of Technical specification (workmanship and other requirements ) is to be followed.

2.2 Requirements for particular works

2.2.1 Site levelling

2.2.1.1 For site levelling levels shall be taken jointly before start & after completion of work and the quantity computed based on the levels. Measurements shall be made only for excavation and no separate measurement for filling shall be made except where earth, borrowed from elsewhere for site levelling work, will be measured separately only for that borrowed portion of earth.

2.2.1.2 In cases where it is not possible or convenient to take measurements from excavated cuts or borrow pits, excavation shall be worked out from filling based on the levels to be taken before and after completion of works. Deduction of 10 percent will be made for voids, however for consolidated fills done through heavy mechanical means, the deduction for voids shall be 5% in place of 10%.

2.2.1.3 In exceptional cases where the quantity is measured on the lorry measurement, loose stacks, boxes or any other similar method with the approval of the Engineer the deduction for voids shall be 20 per cent from the actual quantity.

2.2.2 Excavation

2.2.2.1 Before commencing excavation of foundations for buildings and structures, the initial ground levels shall be jointly recorded. The depth of excavation and the calculation of lift shall be based on this. Normally the initial ground level shall be considered as the level of the site as
handed over to the contractor. In case excavation is planned and approved to be taken up
subsequent to terracing, the terrace level shall be treated as initial ground level.

2.2.2.2 Excavation of foundations, trenches, basements, pits etc., shall be measured to the
dimensions shown in the excavation plan, if any, or of the lowest concrete or masonry
course, as the case may be and the actual depth. Working space and slopes shall not be
measured.

2.2.2.3 Excavation of rock shall be measured from stacks of excavated rock with a deduction of 50
per cent for voids or measured in the solid based on levels.

2.2.2.4 In case of following works, no measurement will be recorded for the excavation beyond
drawing / specification.

(a) In work which will be covered externally with damp proof covering.

(b) In work which requires formwork.

(c) In work which requires workmen to operate from the outside and for guniting and
post tensioned concrete, ground beams etc.

However, if there is a specific provision otherwise in the item/specification/preamble, for
authorised working, it shall be measured accordingly. This working space may be 60 cm.
measured from the face of the structure at lowest level, unless otherwise mentioned.

2.2.2.5 Surface Dressing

Trimming of natural ground, excavated surface and filled up area to remove vegetation
and/or small in equalities not exceeding 15 cm deep shall be described as surface dressing
and measured in square metres unless otherwise specified in the schedule of items/
preamble.

2.2.2.6 Lead

The distance for removal shall be measured over the shortest practicable route and not
necessarily the route actually taken.

The description of the item shall include loading and unloading.

For the purpose of the measurement of the lead, the area excavated shall be divided in
suitable block and for each block the distance from the centre of the block to the centre of
the placed earth pertaining to this block shall be taken as lead.

2.2.3 Back filling/filling

2.2.3.1 In foundations, trenches, basements, pits, etc. and in other like areas, the measurements
shall be the theoretical volume of the filling computed from drawings i.e. the volume
measured under excavation minus the volume occupied by the structure and part filling if
any, done otherwise.

2.2.3.2 In filling under floors the measurements shall be the theoretical volume as per drawings after
deducting the part filling if any, done otherwise.
2.2.3.3 In embankments, the work shall commence only after recording jointly the initial ground levels and the measurements shall be made on the basis of finished cross section and initial ground levels. Where controlled compaction by mechanical compaction is done, 5% deduction for voids shall be made. In case controlled compaction by mechanical means is not done then deduction for voids shall be 10%.

2.2.3.4 Filling/Back filling shall not be measured separately for items of excavation, where filling/back-filling is a part of the composite item and as such is included in excavation item itself.

3.0 ANTI-TERMITE TREATMENT

Measurement shall be the plinth area of the ground floor of the building treated. Dimensions shall be measured to the nearest 0.01 m and area to nearest 0.01 m^2.

4.0 CONCRETE (PLAIN & REINFORCED)

4.1 Concrete

4.1.1 Dimensions shall be measured to nearest 0.01 m except for the thickness of slab, which will be to nearest 0.005 m. Areas shall be worked out to nearest 0.01 m^2 and cubic contents to nearest 0.01 m^3.

4.1.2 The concrete shall be measured as per drawings except in the cases of approved variations which will be measured separately.

No deductions shall be made for the following:

i) Ends of dissimilar materials such as beams, rafters, purlins etc., upto 500 cm^2 in cross section.

ii) Openings upto 0.1 m^2 in area (In calculating area of an opening, the thickness of any separate lintel or sill shall be included in the height. No extra labour for forming such opening or voids shall be measured).

iii) Volume occupied by reinforcement or other embedments such as anchors, inserts, conduits or volume occupied by pipes, sheathing etc. not exceeding 100 sq. cm. each in cross sectional area or as specified.

iv) Small voids not exceeding 40 cm^2 each in cross section.

v) Moulds, drip moulding, chamfer, splay, beds, grooves and rebates upto 10 cm in width or 15 cm in girth.

4.1.3 Columns shall be measured from top of column base to underside of first floor slab and from top of floor to underside of floor slab above thereafter. Beams shall be measured from face to face of columns and will include haunches. Depth of beam shall be measured from bottom of slab and in the case of inverted beams from top of slab. Chajjas and other cantilevers shall be measured from the face of the projection. Where vertical fins are combined with chajja, the latter shall be measured clear between fins. In case chajja is not combined with lintel, beam or slab, it shall be measured inclusive of bearing.

4.2 REINFORCEMENTS
4.2.1 Norms for Steel Consumption

The requirement of mild and high strength deformed bars for various works like reinforcement, guard bars, fan hooks etc. shall be calculated as mentioned below:

i) As per drawing including
   (a) Authorised laps, bends, standard hooks and deviations etc.
   (b) Spacer bars, chairs, hangers, supports, spacer blocks dowels etc. are to be considered for wastage only and not to be measured for payment purpose.

ii) Quantity upto 0.5% of (i) above towards unaccounted wastages, plus

iii) Quantity upto 3% of (i) above towards cut pieces, which shall be pieces below 2m. length. These cut pieces shall not be taken back even though steel has been issued by the client/owner.

4.2.2 Reinforcements shall be measured in lengths to the nearest 0.01 m for various diameters of bar and converted into weight in tonnes to the nearest kg. on the basis of standard weights as per IS : 1786-1986. No allowance shall be made in the weight for rolling margin.

4.2.3 Authorised laps, standard hooks, bends shall be measured.

4.2.4 Spacer bars, chairs, hangers, supports, spacer blocks and unauthorised laps etc. shall not be measured unless otherwise specified.

4.2.5 Dowels neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured for payment.

4.2.6 Modification of already embedded reinforcement, if required due to faulty fabrication or placement, shall not be measured for payment.

4.2.7 The measurements of reinforcements (including authorised laps, hooks, bends) shall be taken only from Bar bending lists or from the drawings except in the cases of approved variations which will be measured as per 4.2.2.

4.2.8 Wire netting and fabric reinforcement shall be described (including meshes and wire/strands) and measured in square metre, unless otherwise specified in the schedule of item. Authorised laps shall be measured. Raking or circular cutting and waste shall be included in the description of item.

4.2.9 Hoop iron shall be fully described and measured in running metres unless otherwise specified in the schedule of item.

4.2.10 Binding wire for the reinforcement shall not be measured separately and shall be included in the item of reinforcement.

4.3 ADMIXTURE
Admixture will be measured separately as specified or on the basis of the requirement as approved by the Engineer.

4.4 FORMWORK

Each dimension shall be measured to the nearest 0.01 m and area to the nearest 0.01 sq.m.

4.4.1 Formwork shall be measured as the actual surface in contact with concrete and paid in sq.m. unless included in the rate for concrete in specific item of work.

4.4.2 All the measurements shall be computed from the drawings except in the cases of approved variations which will be measured separately.

4.4.3 Formwork shall not be measured separately for precast concrete work, grouting and damp proof course which shall be included in the concrete rates.

4.4.4 No measurement for formwork in construction joints shall be made.

4.4.5 Openings upto 0.1 sq.m. shall be neglected, as if non-existent, for the purpose of formwork measurement.

4.4.6 No extra measurement or payment shall be made for making the formwork water proof or for supports, scaffolding, staging, centering, approaches etc.

4.4.7 No measurement shall be taken for the formwork in pockets, openings, chambers, chases etc., in concrete if the cross sectional area is less than or equal to 0.1 sq.m. in each case. If the cross section area of any opening exceeds 0.1 sq.m. the actual area of the formwork shall be measured for payment.

4.5 EMBEDDED PARTS

4.5.1 These shall be measured on the basis of standard theoretical weight of the complete insert according to the drawing/direction.

4.5.2 Embedded steel, which are the integral parts of the embedment according to drawing and are required for anchoring the embedded parts in concrete shall be measured on the basis of the theoretical standard weight. In case of anchor bolts the theoretical weights of the nuts, lock nuts, check nuts and washers shall be added in the measurement for payment.

4.5.3 All bye-works such as jigs, fixtures, templates and other arrangements which are not integral parts of the embedded parts, but necessary to secure those (embedded parts) in position shall not be measured for payment.

4.5.4 Anti-corrosive paint over the exposed surfaces and protection of the anchor bolts with grease tc., shall not be measured for payment.

4.5.5 Modification works necessary to rectify the mistake of already placed embedded parts shall not be measured.

4.6 GROUTING
4.6.1 Grouting shall be measured in volume except in the cases of grouting by special cement compound or epoxy compound which will be measured by number.

4.6.2 Measurement shall be computed from the drawings except in the cases of approved variations which shall be measured separately and subsequently added to or deducted from.

4.6.3 Necessary formwork shall not be measured for payment.

4.7 DAMP PROOF COURSE

4.7.1 Measurement shall be in sq.m. stating thickness and computed from the drawings except in the cases of approved variations which will be measured separately.

4.7.2 Necessary formwork shall not be measured for payment.

5.0 MASONRY

5.1 Dimensions shall be measured to nearest 0.01 m, areas to nearest 0.01 m² and cubic contents to nearest 0.01 m³.

5.2 No deduction shall be made for:

   (i) Ends of dissimilar materials such as joints, beams, posts, girders, trusses, lintels, purlins etc., upto 0.1 m² in section.
   (ii) Openings upto 0.1 m² in area.
   (iii) Wall plates, bed plates, bearing of slab etc., thickness not exceeding 10 cm. and bearing not extending over the full thickness of wall.
   (iv) Cement concrete blocks for holdfasts and the like.
   (v) Iron fixtures such as pipes etc. upto 300 mm. dia. and hold fasts for doors and windows.

5.3 Dressed stonework such as in sills, cornices, column caps, copings etc., shall be measured as the smallest rectangular block from which the finished stone can be worked.

5.4 Honeycomb openings shall not be deducted from the area of honeycomb brickwork.

5.5 Brickwork of full brick width or more shall be measured in cu.m. while of thickness of half brick or less shall be measured in sq.m., unless otherwise specified.

5.6 Reinforcements for reinforced brick work shall be measured separately, unless otherwise specified and no deduction for reinforcement shall be made from brickwork.

6.0 PLASTERING & POINTING

6.1 All plastering and pointing shall be measured in sq.m. unless otherwise described. Dimensions shall be measured to nearest 0.01 m and areas to 0.1 sq.m.

6.2 Ceiling shall be measured between walls or partitions (dimensions before plastering) shall be taken. Measurement of wall plastering shall be taken between walls or partitions for length (dimension before plastering) and from top of floor or skirting to ceiling for height.
6.3 The methods of measurement including the deductions for openings etc., shall be according to the relevant part of IS : 1200 (Part 1 to 28) - 1971 to 1993.

7.0 WHITE WASHING, COLOUR WASHING, PAINTING & OTHER FINISHES.

The method of measurement shall be according to the relevant part of IS : 1200 (Part 13 & 15) - 1987.

8.0 FLOORING, PAVING & FACING WORKS

8.1 The work shall be measured as a complete finished item including necessary underbed, adhesives, dividing strips, joint sealing and necessary grinding, polishing and finishing where specified. The subgrade or the base course shall be measured separately against respective item unless otherwise specified.

8.2 All works shall be measured net, dimensions being measured to nearest 0.01 m and areas to nearest 0.01 sq.m. Any opening less than 0.1 sq.m. in area shall not be deducted nor any extra payment made for that.

8.3 Building paper or water proofing by bituminous felts/mastic asphalt treatment, where specified to be laid below floor, shall be measured separately for payment unless otherwise specified.

8.4 Laps and seams in sheet finishing (linoleum, cork, PVC, rubber & like) shall be deemed to be included in the item itself even if not described explicitly and shall not be measured and paid separately.

9.0 WOODWORK

9.1 All work shall be measured net for finished dimensions as fixed, that is no extra measurement or allowance shall be made for shape, joints, wastage etc. subject to specific provision made in the IS : 1200 (Part 21) - 1973 and for dimensions supplied beyond those specified in the drawing.

9.2 Wooden frame

rught, finished and fixed shall be measured net for overall length nearest to 0.01 m, width and thickness to the nearest 2mm or as specified in the drawing and cubic contents calculated in cubic metres to the nearest three places of decimals.

Wooden shutters of all types

Length and width of the shutters shall be measured net as fixed to the nearest cm. in closed position covering the rebates of the frame but excluding the gap between the shutter and the floor and the area calculated in square metre upto two places of decimal.

Over lap of two leaves of shutter shall not be measured separately.

Hand rails

Hand rails of finished width and depth as specified in the item shall be measured in running metres upto two places of decimal.
9.3 Painting and polishing, unless otherwise described in the schedule of items, shall be measured separately for payment.

9.4 Builder's hardware and fittings for doors windows and ventilators shall be measured separately, unless stated otherwise in the Schedule of Items. Hardware and fittings shall be measured according to IS : 1200 (Part-VII) - 1972.

9.5 Hold fasts for door, window and ventilator frames shall be measured separately.

9.6 **Timber Partitions**
   
   This shall be measured in area calculated in sq. m. to the nearest two places of decimal.

9.7 **Glazed shutters and glazed partitions (Wooden)**
   
   Glazed shutters/glazed partitions with wooden frames shall be measured as a single item in area calculated in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made.

9.8 Provision of making holes/opening/chases in masonry/ concrete flooring etc. for fixing and making good of the same shall not be measured separately for payment.

9.9 Bitumen painting or approved wood preservative of the timber surfaces in contact with masonry/concrete floor etc. shall not be measured for payment.

10.0 **METAL DOORS, WINDOWS & VENTILATORS**

10.1 Door, window and ventilator/louvers as fixed, shall be measured net as clear width between jambs and clear height between floor/sill and underside of lintel, but excluding the gap between door shutters and floor. Dimensions shall be calculated to the nearest 0.01 m., area calculated in sq.m. upto two places of decimal.

10.2 For MS collapsible shutter/gate, rolling shutter sliding folding door, length and breadth shall be measured to the nearest cm. for the clear area of opening as per drawing in which they are installed and calculated in sq.m. to the nearest two places of decimal.

10.3 M.S. Rolling grills, doors of steel plate, sliding door louvered ventilators, gates, grills, as fixed, shall be measured and computed to weight from the size as per drawing unless otherwise specified.

10.4 Glazed doors, windows, louvers, partitions (both steel and aluminium) shall be measured in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made for payment.

11.0 **GLAZING**

11.1 Glazing shall not be separately measured for doors, windows and ventilators unless otherwise specified.

11.2 North light and roof glazing shall be paid as the area from outside to outside of glazing including frames, to the nearest 0.01 sq.m.

11.3 Glazing, where shown in the schedule of items as a separate item, shall be measured from edge to edge of glass as fixed.
12.0 WATER SUPPLY, DRAINAGE, SEWERAGE & SANITATIONS

12.1 All the pipelines buried under soil/masonry/floors/concrete, laid over/underground/along masonry/along under floor shall be measured in metres along the centreline together with fittings/specials up to two places of decimal against respective schedule of items for different diameter (the diameter as specified shall mean nominal bore except PVC pipe) unless otherwise specified.

12.2 All necessary earth work in trenches for laying pipe lines including dewatering, levelling and trimming to the gradient, sand filling in the trenches before laying the pipe, back filling either by sand or by approved borrowed soil after laying the pipe lines including necessary compaction by spraying water and levelling/dressing the same shall not be measured separately for payment unless otherwise specified.

12.3 All required specials, i.e. bends tees, shoes cowls, plug, elbows, unions, caps, checkout and the like excluding valves shall not be measured separately for payment unless otherwise specified.

12.4 All fixing and supporting arrangement of the pipes like the supports, saddles, brackets, clamps, cleats, covering the pipes with concrete in case of pipes laid over ground, special arrangement for supporting the pipe while coming out from the building to the trenches etc. shall not be measured separately for payment, unless otherwise specified.

12.5 All the arrangement in road crossing like cutting the road, diverting the road and drains, concealing the pipes with suitable approved measures, backfilling the area, covering and making good of the road with similar materials/design shall not be measured separately for payment, unless otherwise specified.

12.6 Septic tanks, inspection pits, manholes etc., shall be considered as a composite single item including excavation, dewatering, concrete, masonry, back filling, protection of other service lines and all the like works unless otherwise specified.

12.7 All the valves and all the bathroom/W.C./Kitchen fixtures like bib tap, stop cock, shower, all sanitary wares, towel rails, mirrors etc., shall be measured separately under respective item in the schedule, unless otherwise specified.

13.0 WATER PROOFING, DAMP PROOFING

13.1 Water proofing for roofs

13.1.1 Length and breadth shall be measured in metre up to two places of decimal and area calculated in sq.m. up to two places of decimal.

13.1.2 Measurement shall be made for the net covered area. No measurement shall be made for overlapping for end and side joints and for bends around/along the corners, ends and for special treatment around pipes, rain water gulleys, steel structure and the like etc. No deduction shall be made in the measurement for the opening of area less than 0.1 m² each and no extra payment shall also be made for any special works made around such openings.

13.1.3 Water proofing treatment shall be considered as a single composite item including priming painting coat, water proofing felts, binding bituminous coats, top bituminous coat and pea size gravel or sand finishing etc.
13.1.4 For lime concrete terracing the consolidated thickness shall be considered for measurement.

13.2 For Water proofing treatment in basement

13.2.1 With bituminous felts

13.2.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.2.1.2 Measurement shall be made for the net covered area. Measurement shall be made from the drawing, except in certain special cases where it is impossible to compute from drawing and the measurement shall be made as executed. No measurement shall be made for overlaps, special measures around projected pipes, sealing the bends/rounds and in other cases, necessary projection/overlap for the connection between vertical and horizontal junction etc.

13.2.1.3 Water proofing treatment shall be considered as a single composite item, including priming painting coat, water proofing felts, binding bituminous coats and top bituminous coat etc.

13.3 Mastic Treatment

13.3.1 Length and breadth shall be measured in metres upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.3.2 Measurement shall be made for the net covered area. No deduction in measurement shall be made for opening of area upto 0.1 sq.m. each and no extra payment shall be made for any special treatment around such openings. No measurement shall be made for extra payment for the special works necessary for junctions, corners, roundings, bends for the works around pipes and the like.

14.0 CEILING & LININGS

14.1 Dimensions shall be measured to the nearest 0.01 m., areas to be worked out to the nearest 0.01 sq.m.

14.2 Work formed to circular surfaces shall be measured separately unless otherwise specified.

14.3 All work unless otherwise described shall be measured as flat in sq.m.

14.4 No deduction in measurement shall be made for openings not exceeding 0.4 sq.m. and no extra measurement shall be made for forming such openings.

15.0 ROAD WORK

15.1 Dimensions shall be measured to nearest 0.01 m. Where the thickness is less than 20 cm., it shall be measured to nearest 0.005 m. Areas shall be worked out to nearest 0.01 sq.m. and cubic contents to the nearest 0.01 cu.m.

15.2 Where thickness is measured, it shall be the minimum thickness after compaction.

15.3 Cement concrete bases and roads shall be measured either in sq.m. or cu.m. as specified.
15.4 Unless otherwise specified, expansion and dummy joints shall be described and measured separately and given in running metres stating the thickness and depth of the joints.
SPECIFICATION FOR CIVIL WORKS

PART – VI SAFETY REQUIREMENT FOR CONSTRUCTION WORKS
1.0 GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.

In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the Contractor and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work:

**Indian Standard**

- 4014 - (P-II) – 1967 Scaffolding, Steel Tubular.
- 3696 - (P-I & P-II) Scaffolds and Ladders.
- 1987 to 1991
- 6922 – 1973 Structures Subject to Underground Blasts.
- 8989 – 1978 Erection of Concrete Framed Structures.

2.0 BLASTING

2.1 Detonators and other explosive for blasting shall be taken to the blasting area in the original container or any separate non-metal container. This shall not be carried loose or mixed with other materials. Detonators and explosives must be kept separately.

2.2 No shot for blasting shall be fired except by persons licensed to do so.
2.3 Drilling shall not be resumed after a blast has been fired unless a thorough examination has been made to make sure that there is no unexploded charge.

2.4 Before firing a shot, sufficient warnings by means of whistling and/or otherwise shall be given to get men off the danger area. Blasting areas shall be cordoned off & red flags during day time and red lights during night time displayed prominently marking off the cordoned area.

2.5 All people except those who have actually to light the fuses must be removed to a safe distance of not less than 200 metres as a rule.

2.6 Wherever possible, blasting mats should be used.

2.7 Contractors doing blasting work must have licence and an approved magazine to store explosives.

2.8 Blasting operations shall be carried out during fixed hours of the day which shall be notified in writing.

2.9 Provisions in explosives Rules 1940 as amended from time to time, Indian Explosives Act 1844 (IV of 1884), and others shall be strictly followed.

3.0 EXCAVATIONS

3.1 Sides of all excavations must be sloped to a safe angle, not steeper than the angle of repose of the particular soil. If it is not possible to give a proper slope, the sides of the excavation where there is a danger of fall or dislodgement of earth or any material, shall be securely supported by timber or other type of shoring.

3.2 No excavation or earth work below the foundation level of an adjoining building shall be taken up unless adequate steps are taken to prevent damage to the existing structure or fall of any part.

3.3 Every accessible part of an excavation, pit or opening in the ground into which there is a danger of persons falling shall be suitably fenced with a barrier upto a height of one metre suitably placed from the edge of the excavation as far as practicable.

3.4 No material or load shall be placed or stacked near the edge of the excavation or opening in the ground. The excavated material shall not be placed within 1.5 m of the trench or half of the depth of the trench whichever is more.

3.5 Cutting shall be done from top to bottom. No undercutting of sides of excavation shall be allowed.

3.6 All narrow trenches 1.2 m or more depth, shall at all times be supplied with atleast one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of the trench to atleast one metre above the surface of the ground. The side of the trenches which are 1.5 m or more in depth shall be stepped back to give suitable slope, or securely held by planking, strutting and bracing so as to avoid the danger of side collapse.

3.7 Materials shall not be dumped against existing walls or partition to a height that may endanger the stability of the walls.

3.8 While withdrawing piled materials like loose earth, crushed stone, sand, etc., from the stock piles, no over hanging shall be allowed to be formed in the existing dump.
3.9 No material on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or public or any other agency at work.

4.0 DEMOLITION

4.1 On every demolition job, danger signs shall be conspicuously posted all round the structure and all doors, openings giving access to the structure shall be kept barricaded or marked except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for escape of workmen during any emergency.

4.2 During night, red lights shall be placed on or about all the barricades.

4.3 Where in any work of demolition it is imperative, because of danger existing to ensure that no unauthorised person shall enter the site of demolition outside working hours, a watchman should be employed. In addition to watching the site he shall also be responsible for maintaining all notices, lights and barricades.

4.4 All the necessary safety appliances as per IS :4130 shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

4.5 The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure the same shall be got vacated to avoid any danger to human life.

4.6 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power line required for demolition work itself.

4.7 All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.

4.8 All the mains and meters of the building shall be removed or protected from damage.

4.9 If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored or braced suitably.

4.10 Walkways and passage ways shall be provided for the use of the workman who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.

4.11 All nails in any kind of lumber shall be withdrawn, hammered or bent over as soon as such lumber is removed from the structure being demolished, and placed in piles for future cleaning or burning.

4.12 All the roads and open area adjacent to the work site shall either be closed or suitably protected.

4.13 No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electricity charged.
4.14  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 the building shall be so overloaded with debris or materials as to render it unsafe.

5.0  VEHICLE

5.1  No person shall board any vehicle or equipment when it is in motion.

5.2  Suitable blocks shall be placed against the wheels of a vehicle when it is used for tipping materials into excavation or a pit or over the edge of any embankment or earthwork to avoid the danger of its running over the edge.

5.3  All workers shall stand clear of the vehicle while it is dumping. If the material being dumped is very heavy or sticky, dump hooks shall be used or dumper shall be clamped to prevent any danger of its tripping.

5.4  Materials shall not be allowed to be loaded in a vehicle so as to project horizontally beyond the sides of the body of the vehicle. All materials projecting beyond the front or rear shall be indicated by a red flag in the day and with red light in the night.

5.5  Driver of the truck or any heavy vehicle shall not reverse it unless assisted by a signal man who shall have a clear view of the driver and the area beyond the truck during reversing operation.

5.6  Maximum speed of a heavy vehicle must not exceed 15 km. per hour.

6.0  SCAFFOLDING, GANGWAYS, LADDERS & SHUTTERING
6.1 For all work that cannot be done from the ground level or from part of any permanent structure or from other available means of support, soundly constructed scaffoldings of adequate strength shall be used as a safe means of access to places of work.

6.2 All scaffolding shall be securely supported or suspended and wherever necessary be properly braced to ensure stability.

6.3 Chains, ropes or other lifting materials used for the suspension of scaffoldings must be of adequate strength and shall be of tested quality.

6.4 All such chains and ropes used for the suspension of scaffoldings shall be properly fastened to safe anchorage points.

6.5 The platform of a suspended scaffolding shall be sufficiently wide. Suspended scaffolding shall have hand rail on 3 sides of about 1.0 m height.

6.6 All working platform and stages from which workers are liable to fall shall be of adequate width depending on the type of work done and closely boarded and planked.

6.7 Scaffolding or staging more than 3.5 m above the ground or floor, suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise secured atleast 1 m high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure. The platform shall also be provided with toe boards of atleast 150 mm high so placed as to prevent the fall of materials and tools from there.

6.8 All platforms or gangways, runways and the stairs shall be kept free from unnecessary obstructions, materials or junk.

6.9 Working platforms, gangways & stairways shall be so constructed that they shall not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.5 m above ground level or floor level they shall be closely boarded, shall be of adequate width and shall be suitably fenced.

6.10 Every opening in the floor of a building or in a working platform shall be provided with suitable fencing or railing whose minimum height shall be 1 m to prevent the fall of persons or materials.

6.11 Every ladder shall be securely fixed at top and bottom. A ladder more than 5 m long shall have a prop.

6.12 All ladders used shall be of good construction, sound materials and adequate strength. Ladders with defective or missing rungs shall not be brought into use. The spacing of rungs shall not exceed 30 cms and these shall be recessed atleast 12 mm into rails.

6.13 All ladders or rungs used for vertical height of more than 10 m shall have an intermediate landing. All such intermediate landings shall be provided with guard rails to a height of atleast 1 m.

6.14 Every ladder shall be securely placed so that it cannot move either at the top or at the bottom and it shall rise to a height of atleast 1.2 m above the place of landing.
6.15        No portable single ladder shall be over 8 m in length.

6.16        Spacing between the side rails of the ladder shall not be less than 300 mm for ladders upto 3 m in length. For longer lengths, this shall be increased at 6 mm for each additional 0.3 m of length.

6.17        Metal ladders must not be used for electrical work or near electric circuit of equipments.

6.18        All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

6.19        Unfinished scaffolding which is under construction shall be prominently marked as unsafe and any access points shall be closed.

6.20        All Planking and Decking on walkways and scaffolds should be adequately supported at each end of the plank and intermediately if necessary. Planks should not be allowed to cantilever beyond the last support but should be overlapped if necessary on to the next plant.

6.21        Shuttering

The above remarks shall be applicable for this also. Shuttering, particularly for slabs, should be treated as a scaffold. Unfinished shuttering should be marked as dangerous similarly the finished formwork should be adequately supported, care being taken to avoid trap door effects.

7.0         MOBILE LIFTING APPLIANCES

7.1         No mobile lifting appliances shall be used on a sloping surface unless adequate precautions are taken to ensure stability.

7.2         Adequate precautions shall be taken to see that jib of the mobile crane does not come in contact with overhead electric transmission line.

7.3         Only one person shall give signals to the operator of mobile lifting appliances.

7.4         Maximum load to be lifted by lifting appliances shall be marked in a position where it can be clearly seen by the crane driver and the operator.

7.5         No load shall be raised, lowered or suspended from a chain or rope having a knot in any of the part.

7.6         No chain which is joined to another chain by means of bolt and nut shall be used for raising, lowering or suspending any load.

7.7         All chains, ropes and lifting gears shall be carefully examined and tested by a competent Maintenance Engineer atleast once in every quarter.

7.8         When the work is stopped or when the mobile lifting equipment is not in operation, the boom must be lowered to the horizontal position and tied securely in place to prevent accidental drop.

7.9         No person shall walk under a load which is swinging by a lifting equipment.

Guide rope must be attached to the load to prevent its swinging.
7.10 The foot blocks of the crane before starting work shall be securely supported and firmly anchored to prevent its movement in any direction.

7.11 Use of Hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards of condition.

7.11.1 These shall be of good mechanical construction, sound material and adequate strength and free from defect and shall be kept in good working order.

7.11.2 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.

7.11.3 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine or give signals to the operator.

7.11.4 In case of every hoisting machine and every chain ring hook shackle swivel and pulley block used in hoisting or lowering or as means of suspension the safe working load shall be ascertained by adequate means, every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working loading, each safe working load of 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 the safe working load except for the purpose of testing. Mobile cranes shall have the working load and the radius of jib for the load marked on it.

7.11.5 The top pulley for hoisting a load shall be opened monthly and the spindle inspected to see if any undue wear has taken place and for greasing.

7.11.6 In case of departmental machine, the safe working load shall be notified by the Engineer concerned. As regards contractor's machines the Contractor shall notify the safe working load of the machine to the Engineer whenever he brings any machinery to site of work and get it verified by the Engineer concerned.

7.12 Motors, gearing, transmission, electric wiring and other dangerous part of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce to the minimum, the risk of accidental descent of the load. Adequate precautions shall be taken to reduce to the minimum, risk of any part of a suspended load becoming accidentally displaced.

8.0 RIVETTING, WELDING & GAS CUTTING & STEEL ERECTION

8.1 Rivetting

8.1.1 Bolts covered with wet or slippery compounds shall not be used in fabricating structural work.

8.1.2 The rivet heater must keep the rivet heating equipment as near as possible to the place of work.

8.1.3 A pail of water shall always be kept ready for quenching fire when stopping rivetting work.

8.1.4 Hot rivet shall not be thrown across aisles and shaft ways.
8.1.5 Metal buckets for catching hot rivets must have false wooden bottoms to prevent rivets from rebounding.

8.1.6 All rivets, bolts, nuts, and other tools must be kept in boxes and not left loose. (For any further safety measures relevant Indian Standards and safety specifications of structural section shall be referred to).

8.2 **Welding & Gas Cutting**

8.2.1 All cylinders must be used and stored in upright position only.

8.2.2 Cylinders must be stored away from open flames and other source of heat.

8.2.3 Oxygen cylinders must not be stored near other cylinders containing gas or oil, grease or other combustible materials.

8.2.4 While the cylinder is in use, the cylinder valve key or wrench must be placed on the valve spindle.

8.2.5 Before a cylinder is moved, the cylinder valve must be closed.

8.2.6 Gas cutting torches must be lighted by means of friction flames or similar other methods and not with matches.

8.2.7 When torches are being changed or welding stopped for some time valves for all cylinders must be closed.

8.2.8 The coloured lenses used for welding or gas cutting must be of proper shade for the work being done.

8.2.9 Suitable eye protection equipment such as goggles, hand shields etc., must be used by persons engaged in welding or gas cutting operations.

8.2.10 Before any heavy structural member is gas cut, make sure that it is cleared and supported by ropes, cables, chains or any other means to prevent its dropping or swinging.

8.2.11 Cylinder valves and connections are not to be lubricated. All oily or greasy substances must be kept away from cylinders.

8.2.12 Substantial and incombustible screen must be used below or near the welding operations, if there is a possibility of a spark falling on other workmen engaged in work closely.

8.2.13 All air pipe lines and air hoses must be frequently inspected. Air hoses shall not be used for dusting or for cooling purposes.

8.3 **Steel Erection**

8.3.1 All persons shall stand clear when a crane is sorting or shifting steel girders or other structural materials.

8.3.2 No person shall stand, walk or work beneath any suspended load.

8.3.3 Guide rope must be used for guiding lifting loads.
8.3.4 When guiding a beam or fabricated structure or erection it shall be so held that the employees hands do not get jammed against other objects.

8.3.5 Safety belts equipped with suitable life lines must be used by persons working at heights and standing on structural members. Life line must be tied to an independent support. For any further safety measures, for Structural Steel Works, IS : 7205 - 1974 shall be referred to.

9.0 SAFETY APPLIANCES

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

9.2 Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes, shall be provided with protective goggles.

9.3 Those engaged in welding works shall be provided with welder's protective eye-shields.

9.4 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

9.5 When workers are employed in sewers and manholes which are in use, the Contractor shall ensure that the manhole covers are opened and chambers are ventilated atleast for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.

9.6 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:

9.6.1 No paint containing lead or lead products shall be used except in the form of paste or ready made paint.

9.6.2 Suitable face mask should be supplied for use by them when paint is applied in the form of spray on a surface having lead paint dry rubbed and scraped.

9.6.3 Overalls shall be supplied by the Contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

9.7 The workers going into inspection chamber shall have gas masks, gum boots and rubber gloves while working inside. After coming out they shall have some disinfectant from the first aid box for proper washing.

9.8 All necessary personnel safety equipment such as safety helmets, safety boots, safety belts, leather gloves for welders, clear glass safety goggles etc., as considered adequate by the engineer have to be kept available for the use of persons employed at the site of work and maintained in condition suitable for immediate use and Contractor shall take steps to ensure proper use of equipment by the workers.

9.9 All the persons entering the tunnel shall be provided with protective wear, such as helmets, steel toe safety shoe, gum boots or other suitable type of protective foot wear. In the case of steeply inclined tunnels and in shafts, safety belts shall also be provided.
9.10 Sign boards 1 x 1.5 m in size with the following wording shall be erected at the access to these areas. "CONSTRUCTION AREA, HELMET REQUIRED BEYOND THIS POINT"

9.11 No loose garments or ragged clothing shall be worn by the personnel engaged in tunneling operation.

9.12 A telephone system shall provided to ensure a positive and quick method of communication between all control location inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 m

9.13 Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning signals by any one of the following means.

9.13.1 By electrically operated bells, operated by battery/dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. The position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.

9.13.2 By the use of two field (magnet type) telephone.

9.13.3 Any other suitable arrangement like walkie-talkie.

9.14 Arrangement for rendering prompt and adequate first aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in-charge of the project. Depending upon the magnitude of the work the availability of an ambulance at a very short notice (at telephone call) shall be ensured.

9.15 First-aid arrangements commensurate with the degree of hazard and with the number of workers employed shall be maintained in a readily accessible place throughout the working hours. At least one experienced first-aid attendant with his distinguishing badge shall be available on each shift to take care of injured persons. Arrangements shall be made for calling the medical officer, when such a need may arise. It is recommended that foreman/assistant foreman/supervisor/ permanent workmen who are normally present at each working phase in each shift are given adequate training on first-aid methods to avoid employment of a separate attendant.

9.16 Stretchers and other equipment necessary to remove injured persons shall be provided at every shift.

9.17 Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.

10.0 ELECTRICAL

10.1 Only authorised persons shall handle or otherwise interfere with electrical equipment. Any person detecting electrical apparatus being handled by an unauthorised person or equipment in unsafe condition must report the matter to the Engineer concerned.

10.2 No person shall work on any live electric conductor or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf.
10.3.1 After isolating the equipment from the source of supply before the work begins, a sign 'DON'T SWITCH ON' must be hung on or near the switch to avoid its being accidentally or inadvertently switched on when persons are working.

10.3.2 Take out the fuses and keep in safe custody.

10.3.3 The switch may be locked if locking arrangement exists.

10.3.4 Earth the equipment, before work, to discharge it and short the terminals as a precautionary measure against accidental switching ON.

10.3.5 After the work is finished take out Earthing and shorting link.

10.3.6 Remove all tools and materials from the site of work. Replace the fuses and unlock the switch.

10.3.7 The switch shall only be put 'ON' by the person who switched it 'OFF' or by the person authorised by him in writing.

10.4 When working on live equipment use one hand only whenever possible, it is advisable to keep the other hand behind the back. Shocks from hand to hand are most dangerous.

10.5 All persons handling electrical gear in elevated position must use safety belts. Even a slight shock may cause loss of balance and fall.

10.6 No one shall attempt to extinguish a fire on or near a live electrical apparatus with water. Water is a good conductor of electricity. Use extinguishers wherever provided. Use sand and blankets etc., if available.

10.7 No person shall use any part of electrical equipment for storing or hanging clothes, umbrellas or other articles. Serious accidents occur from this practice.

10.8 For attending the work on O.H. lines or equipment use wooden ladders. Metallic ladders shall not be used.

10.9 Use insulated tools and ensure the insulation is in proper condition periodically at least once in three months. Use rubber gloves wherever possible.

10.10 As far as possible verbal instructions shall be avoided in case of pre-arranged shut-down of electrical apparatus.

10.11 When workers are employed for electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

11.0 MISCELLANEOUS

11.1 The Contractor shall provide necessary fencing and lights to protect the public from accident.

11.2 Fire extinguishers adequate in number shall be kept by the Contractor at the site of works where there is risk of fire hazard.

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

11.5 These safety provisions shall be brought to the notice of all concerned by displaying on a Notice Board at a prominent place at the work spot. The persons responsible for compliance of the code shall be named therein by the Contractor.

11.6 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Engineer and Owner.

11.7 Not withstanding the above clauses there is nothing in those to exempt the Contractor from the operations of any other Act or Rule in force in the Republic of India.

11.8 All storage, handling and use of flammable liquids shall be under the supervision of qualified persons. Flammable liquid shall not be stored inside the tunnel

11.9 All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and 'NO SMOKING' signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.

11.10 All combustible materials shall be continuously removed from such areas where flammable liquids are stored, handled and processed. All spills of flammable liquids shall be cleared up immediately. Containers of flammable liquids shall be tightly capped.

12.0 REPORTING OF ACCIDENT

All accidents, major or minor must be reported immediately. The Contractor, will provide first aid to the injured person immediately and the injured person shall report to the first aid station along with the 'INJURED ON WORK' form duly filled in quintuplicate and submit to the Medical Officer of the First Aid Station”.

Serious Injury

In case of serious injury, the following procedure shall be adopted by the Contractor:

1. Provide First Aid at his own First Aid Station.
2. Take the injured person to the Hospital along with the "INJURED ON WORK" form duly filled in.

3. Reporting the accident to the Owner/Engineer by the Contractor.

**Fatal Accident**

Fatal accident must be reported immediately to the Engineer/Owner as well as to the Police.

**Penalty**

Failure to observe the Safety Rules will make the Contractor liable to penalty by way of suspension of work, fine and termination of contract.
SPECIFICATION FOR CIVIL WORKS

ANNEXURE
LIST OF IS & IRC CODES REFERRED


IS 2386 (Part 1 to 8) – 1963 : Method of Test for aggregates for concrete.


IS 1599 – 1985 : Method of Bend Test.


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IS 3495 (Part 1 to 4) -1992 : Method of Test for burnt clay building bricks.
IS 1121- 1974 : Method of test for determination of strength properties of natural building stone.
IS 1124 – 1974 : Method of test for determination of water absorption Sp. Gr. etc. of building stones
IS 1127 – 1970 : Recommendation for dimensions and workmanship of natural building stones for masonry work.
IS 2185 ( Part-1)-1979 : Specification for concrete masonry unit Hollow and solid concrete blocks.
IS 2116 – 1980 : Specification for sand for masonry mortar
IS 6041 – 1985 : Code of practice for construction of Auto claved
Cellular concrete block masonry.

- **IS 6441 (Part 1 to 9) - 1972 & 1973**: Method of Test for Autoclaved Concrete Products.
- **IS 460 (Part 1 to 3)-1985**: Specification for Test Sieves.
- **IS 2818 – 1990**: Indian Hessians.
- **IS 653 – 1992**: Linoleum sheets and tiles.
- **IS 287 – 1973**: Recommendation for maximum permissible moisture content of timber used for different purposes.
- **IS 2202 (Part-1) - 1983 & 1991**: Specification for wooden flush door shutters (Solid
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regulated) for light door weighing upto 40 Kg.


IS 7197 – 1974 : Specification for Double action floor spring (without oil check) for heavy doors.


IS 419 – 1967 : Putty for use on window frames.


IS 7452 – 1990 : Hot rolled steel sections for doors, windows and ventilators.


IS 733 – 1983 : Wrought aluminium and aluminium alloy bars, rods and sections (for general engineering purposes).

IS 6248 – 1979 : Specification for metal rolling shutters and rolling grills.


IS 101 (Part 1 to 8) - 1964 to 1993 : Method of sampling and test for paints, varnishes and related products.

IS 2074 – 1992 : Ready mixed paint, air drying, red oxide zink chrome, priming.

IS 5410 – 1992 : Cement paint, colour as required.

IS 427 – 1965 : Distemper, dry, colour as required.

IS 428 – 1969 : Distemper, oil emulsion, colour as required.


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<td>IS 1504 – 1974</td>
<td>Bees Wax.</td>
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<td>IS 3536 – 1966</td>
<td>Ready mixed paint, brushing, wood primer pink.</td>
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<td>Sand cast iron spigot and socket soil pipe.</td>
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<td>Centrifugally cast (spun) iron pressure pipes.</td>
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<td>IS 1199 – 1959</td>
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IS 851 – 1978 : Specification for synthetic resin adhesive for construction work (non structural) for wood.


IS 6248 – 1979 : Specification for metal rolling shutters and rolling grills.


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AIR CONDITIONING,
VENTILATION & AIR POLLUTION
CONTROL SYSTEM
(CHapter-08)
GENERAL SPECIFICATION
FOR
AIR CONDITIONING, VENTILATION & AIR
POLLUTION CONTROL SYSTEM
(GS – 08)

MECON LIMITED
RANCHI - 834002

No. MEC/S/1901/11/38/0/00/00/F1889/R2
JULY, 2007
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1.0 SYSTEM SPECIFICATION OF AIR CONDITIONING SYSTEM (SS1)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Air Conditioning System with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Air Conditioning System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Air Conditioning System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description

This specification specifies general requirement of refrigeration and air-conditioning system for different application.

In general following types of air-conditioning units and accessories are required to be installed:

- AIR HANDLING UNIT – ES1
- CENTRIFUGAL FAN – ES4
- CENTRIFUGAL PUMP – ES5
- VAPOUR ABSORPTION M/C (VAM) – ES6
- CENTRALISED AIR CONDITIONING SYSTEM – ES7
- COOLING TOWER – ES9
- DAMPERS – ES11
- DUCTING NETWORK FOR HVAC SYSTEM – ES13
- FILTER DRY TYPE – ES15
- PACKAGE TYPE A/C SYSTEM – ES19
- PROPELLER FAN – ES20
- THERMAL & ACOUSTIC INSULATION FOR HVAC APPLICATION – ES17
- TUBE AXIAL FAN – ES23
- VALVES – ES24
- WINDOW & SPLIT TYPE A/C SYSTEM – ES25

Design Consideration:

For Design Ambient Temperature, internal heat load due to equipment, lighting, solar radiation, occupancy and inside design conditions refer job requirement of technical specification. The air-conditioning system will be designed to operate continuously round the clock twenty four (24) hours a day for all seasons of the year.

Following Indian Standards shall be followed for designing Air Conditioning System:

<table>
<thead>
<tr>
<th>Indian Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS-655-1963 (RA-1999)</td>
<td>HVAC System duct</td>
</tr>
<tr>
<td>IS-659-1964 (RA-1991)</td>
<td>Safety code for A/C system</td>
</tr>
<tr>
<td>IS-778-1984 (RA-1995)</td>
<td>Copper Alloy Gate, Globe, Check Valves</td>
</tr>
<tr>
<td>IS-1239-1990 (RA-1998 Part-1)</td>
<td>MS Tubes &amp; Pipes</td>
</tr>
<tr>
<td>IS-1391-1992 Part-1</td>
<td>Unitary (Window) A/C Unit</td>
</tr>
<tr>
<td>IS-1391–1992 Part-2</td>
<td>Split A/C Unit</td>
</tr>
</tbody>
</table>
IS-2712-1998  CAF Gaskets  
IS-3588-1987 (RA-1994)  TA Fan  
IS-3589-2001  Steel pipes for water & sewage DD-168.3 to 2540mm  
IS-4894-1957 (RA-1994)  Centrifugal Fan  
IS-5312 (Part 1)-1981 (RA-1995)  Check valve  
IS-5822-1994  Laying of pipe line  
IS-8148-1976 (RA-1995)  Package air conditioner  
IS-10470-1983  Specification of air cooled heat exchanger  
IS-11304-1985 (RA-1993)  Air Pollution Control in Steel Plants  
IS-11327-1985  Refrigerant condensing units  
IS-11338-1985 (RA-1991)  Thermostat for HVAC  
IS-11446-1985  Air borne noise of compressor  
IS-11461 – 1985  Code of practice for compressor safety  
ASHRAE handbook  System Design by ‘Carrier Air Conditioning Company’

The following design data shall be considered for selecting and sizing various equipment for chilled water plant, air conditioning and ventilation systems:

<table>
<thead>
<tr>
<th>SEASON</th>
<th>TEMPERATURE 0°C (DBT)</th>
<th>RELATIVE HUMIDITY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Zone side (20 m from hot metal/liquid steel handling)</td>
<td>60</td>
<td>26</td>
</tr>
<tr>
<td>Other zones</td>
<td>45</td>
<td>26</td>
</tr>
<tr>
<td>MONSOON</td>
<td>33</td>
<td>70</td>
</tr>
<tr>
<td>WINTER</td>
<td>10</td>
<td>-</td>
</tr>
</tbody>
</table>

In general the different air conditioned served electrical premises shall be maintained at 23±2°C and 55±5% RH.

All glasses in Air-conditioned served premises shall be double glass type with airtight double door entry provision.

For improved water quality in refrigeration system chemically treated water shall be considered as make-up for corrosion protection. Alternatively soft water plant shall be installed for make-up water supply to A/c system.
Chilled water pipe line shall be laid over ground.

For better distribution of chilled water in the network, ring main shall be considered. Alternatively, reverse return line shall be considered for vertical chilled water distribution at different floor. At the end of main supply and return chilled water line provision shall be kept with isolation valve for hooking up with adjacent plant chilled water network. Interfacing of chilled water network form one plant to other shall be done by Purchaser separately depending upon requirement.

Preferable Exhaust fan rpm shall not exceed 900. All pumps (above 15m$^3$/hr capacity) shall be horizontally split type with maximum RPM of 1,500. Monoblock pump can be used for capacity less than 15 m$^3$/hr.

Remote monitoring from central control room through main automation system for all critical areas under AC systems shall be provided. Provision for monitoring of chilled water flow quantity, temperature and served premises temperature shall be kept from central control room station.

Chilled water plant shall be selected such that it shall have 20 % more capacity rating than design calculation for future scope and interconnection with other adjacent plant.

The following velocities will be maintained in duct line for different air conditioning systems.

1) Main header ducting: 6 to 8m/sec.
2) Branch ducting: 5 to 7m/sec.
3) Supply air grill: 2 to 3m/sec.
4) Return header ducting: 5 to 6m/sec.

Noise level generated in Central plant, Package AC plant, AHU and duct line shall not be transmitted to the served premises. Noise level in the served premises will not exceed 65 dB (A).

For control of temperature and dehumidification of the conditioned premises, thermostat and humidistat will be provided in the package A.C. plant room/AHU Room.

High efficiency filter and strip heater will be installed in the supply air duct at the discharge end of blower and the strip heater will be interlocked with the blower to prevent independent control/switching of heaters. Pan humidifier shall be installed in the Air Handling Unit Plant Room if required for critical control of R.H. Level.

Make up air supply to AHU/package AC plant room shall be provided with filter and damper.

Filter: Efficiency of pre filter will be 90% down to 10 micron and fine filter will be 99% down to 5 micron. High efficiency filter will be installed in the supply air duct at the discharge end of blower in line with job specification requirement. For details refer ES16.

Local control of fan, pump, blower shall be provided near installation area for ON/OFF operation as required.

Humidity Control:

The strip heater will be installed in the supply air duct at the discharge end of blower for dehumidification purpose and the strip heater will be interlocked with the blower unit to prevent independent control/
switching of heaters. Safety thermostat shall be installed in the duct line near strip heater for safety precaution.

Pan type humidifier shall be installed in the air handling plant room for adding moisture if required for critical control of R.H. Level. Safety thermostat shall be installed in the pan humidifier chamber near immersion heater for safety precaution. In Pan humidifier chamber make–up water line, overflow, drain provision with gate and float valve arrangement shall be provided.

**Condenser cooling circuit.**

Centrifugal pump and cooling tower for condenser cooling shall be supplied in line with job specification requirement for water-cooled type condensing unit. For air cooled condenser unit selection maximum ambient temperature factor shall be considered for capacity selection

Rubber/Neoprene gaskets will be used on all bolted joints as a seal against water leakage.

Water pipe line will be of MS Heavy ( C ) Class and as per IS 1239 - 1990, (part I) (RA – 1998), upto a size of 150 NB, IS 3589-2001 for sizes beyond 150 NB MS, spirally welded, 6mm thick & conforming to IS:3589. Pipe fittings up to 150 NB will be as per IS 1239-1992 (Part II), Amendment 2000. Fabricated fittings manufactured from pipes may be provided for pipes of size 200 NB & above. Velocity of water in pump suction line and delivery line will be within 1.25 and 2 m/sec respectively.

Pot /Duplex strainer will be provided in suction line of pump and ball valve/ butterfly valve will be provided in the delivery side of pump.

Butterfly valve/ ball valve will be provided in water pipeline at condenser inlet & outlet, AHU cooling coil inlet & outlet, pump inlet & outlet.

For better distribution of chilled water in the network in vertical line reverse-return line shall be provided for balancing of water flow at consumer points. However for multiple consumer points in horizontal line balancing valve shall be provided at chilled water return branch line.

Insulated drain piping network is to be included as required for steam condensate drain, with isolation valves at proper places.

Pipe supports will be steel, adjustable for weight and coated with rust preventive primer and finish coated with Aluminum paint. Where pipe and clamp are of dissimilar material a gasket will be provided in between.

All piping will be tested to hydrostatic test pressure of at least one and half times the maximum of operating pressure for period of not less than 2 hours.

**Thermal and acoustic insulation :**

For details refer ES22. Thermal and acoustic insulation for air conditioning systems shall be considered in line with job specification requirement. However, following minimum insulation work shall be considered.

- **a)** Inside surface of the packaged a/c blower/AHU Blower section.
- **b)** Supply air tail end duct to prevent condensation
- **c)** All supply air and return air duct line passing through non-air conditioned premises.
- **d)** Acoustic insulation of duct line at blower outlet up to 5 m length minimum.
- **e)** Steam condensate drain
f) Under deck insulation of sunlit exposed roof

g) Chilled water pump, chilled water pipeline, valves, chiller, expansion tank as per job specification requirement.

**Fire safety**

No combustible material, lining like insulating material will be used anywhere in the entire air-conditioning system of shop. AC system blower, motorized fire dampers / Solenoid operated fire dampers in the duct shall be inter locked with fire detection system to stop air flow.

**Control & Instrumentation**

The following instrumentation and necessary interlock and controls to be provided for air conditioning system:

i) HP/LP cutout switch.

ii) Cooling thermostat, heating thermostat, Operating and antifreeze thermostat & Humidistat.

iii) Pressure gauge & temperature gauge (150-mm dial type)

iv) Water flow switch /differential pressure switch with interlock and signal.

v) Dry bulb & wet bulb thermometer for all air conditioned premises.

vi) Thermostatic expansion valve, sight glass, refrigerant strainer,

vii) Steam pressure and flow control of Vapor Absorption based system.

viii) Chilled water flow and condenser cooling water flow rate

Any other instrumentation required for the system will be indicated & provided by the Tenderer.

**Guidelines to eliminate interference between ducts, lighting and false ceiling**

Minimum clearances for duct routing will be as follows:

A minimum clearance of 100 mm will be provided between beam bottom and top of duct to take care of duct fabrication, flanges, insulation and allowances for civil construction.

Minimum clearance of 200 mm will be provided between duct bottom and false ceiling to take care of collar fitting, variation in levels of false ceiling and floor levels, if any.

The successful Tenderer will study the false ceiling drawing. Additional grid work, if found necessary, based on diffuser sizes, shall be carried out. Size of the diffuser color will match with false ceiling grid. For served premises, return air recess may be provided at the periphery all around.

**Sequence of preparation of drawings**

i) Duct routing drawing will be prepared based on air conditioning requirement.

ii) Duct routing and diffuser locations will be checked for interference if any with light fittings and false ceiling grid as per the Architectural/Electrical drawings. The diffusers and light fittings will be in different rows, as far as possible.

iii) The finalised duct/diffuser layout drawing will be drawn on the false ceiling grid drawing before submission for approval.
Construction supervision

Interference during construction stage due to lack of supervision and co-ordination etc., will be corrected during erection by the AC system Successful Tenderer. The false ceiling Tenderer will draw the grid on the ceiling. The AC system Successful Tenderer will make the exact location of diffusers on the ceiling. Similarly, locations of light fittings on the ceiling shall be considered. AC system Successful Tenderer will co-ordinate in this regard with other Contractors to avoid any interference at a later stage. By using plumb, from locations of diffusers drawn on ceiling, the duct fabricator will erect the main and branch ducts. However, collars should be cut only after the false ceiling is properly leveled.

Suggested sequence of operation

i) Under deck insulation shall be completed.
ii) Main duct will be erected by the Successful Tenderer.
iii) Hangers for false ceiling & lighting etc., will be placed.
iv) Skeleton false ceiling with grid main runners will be erected.
v) Branch duct to be erected as per center lines of grid/main runner.
vi) False ceiling to be leveled and grid to be provided for lights and diffusers.
vii) Collars to be cut by the Tenderer to match the false ceiling grid and level.
viii) Fixing of diffusers on to the collars after leveling the false ceiling.
ix) The diffuser level and false ceiling level will be properly matched for good aesthetic appearance. The false ceiling panel opening will be done by the Tenderer for diffuser fixing.
x) The AC system Tenderer will plan the activities of duct erection in consultation with other Tenderers, (namely, Electrical and Civil) so as to avoid delays and extra work by all concerned.
xi) Concerted efforts will be made by the AC system Tenderer together with other agencies for proper erection of ducting and diffusers avoiding any interference with electrical works and false ceiling grid.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

1. Type of refrigeration / air conditioning system
2. Total capacity of air conditioning system
3. Make of equipment
4. Design cooling load
5. Indoor climatic condition shall be maintained
6. Total power requirement
7. Total water requirement
8. Any specific design consideration
9. Noise level at 1m distance from the AC equipment
10. Noise level at served premises
2.0 DUST EXTRACTION SYSTEM SPECIFICATION (SS2)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Dust Extraction System with all accessories required to be installed to achieve desired performance in all respect. Specific technical requirement of Dust Extraction System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Dust Extraction System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description Of The Dust Extraction Systems

Dust extraction systems shall comprise of suction fan, dust extractor, ducting network, dust disposal system, electrics, instruments & controls.

This specification specifies general requirement of Dust Extraction system for different application.

In general following equipment specification (ES) shall be referred

- BAG FILTERS – ES3
- CENTRIFUGAL FAN – ES4
- CENTRIFUGAL PUMP – ES5
- DUCTING NETWORK FOR DE SYSTEM – ES12
- CYCONES, MULTI-CLONES, PRE-COLLECTOR – ES10
- ELECTROSTATIC PRECIPITATORS – ES14
- SCRUBBER – ES21
- THERMAL INSULATION FOR HOT APPLICATION – ES18
- VALVES – ES24

DESIGN CRITERIA

1. All the rotating parts shall be statically and dynamically balanced. Monitoring ports in ducting and stack with platforms, approach ladders/stairs and other requirements shall be strictly as per the latest emission standards published by Central Pollution Control Board.

2. The efficiency of the dust cleaning equipment shall be such that the emission from stack should not be more than 50 mg/Nm$^3$ unless otherwise specified in the job specification. The average inlet air dust concentration may be taken as 10~15 gm/Nm$^3$ unless otherwise specified in the job specification.

3. The dust extraction systems shall be such that the work zone dust concentration Respirable Particulate Matter (RPM) less than 10 micron should be limited to 1mg/Nm$^3$ over back ground level unless otherwise specified in the job specification.

4. The capacities of the dust extraction systems shall be selected considering at least 10% for safety over the calculated values.

5. Following Indian Standard may please be followed as design guidelines:
6. The duct lines shall be designed self balanced. Successful tenderer has to furnish pressure drop calculation and system capacity selection calculation before carrying out detail engineering of DE system.

7. The dust extraction system shall be designed based on norms specified in the Hand Book of American Conference of Governmental Industrial Hygienists (ACGIH) with fines factor and to meet the required fugitive emission standard based on the party’s experience.

The Successful Tenderer should calculate and decide the systems capacities of their own using the standard norms. However, in no case, the systems capacities should be less than as specified in job specification.

7. The dust extraction equipment shall be located near to the building. Approach, handling and hoisting facilities shall be provided for the equipment. Monitoring port holes of 100mm diameter with plug, platforms, approach ladders/ stairs, power socket of single phase, 50 Hz, 230 V, 15 A and monitoring equipment lifting facilities shall be provided as per the emission standards published by Central Pollution Control Board.

8. All stacks for discharge of clean air from dust extraction systems shall have a minimum height of 30m or 3m above top of roof of the tallest adjacent building / structure whichever is higher or as specified in the job specification. The efflux velocity from the stacks for dust extraction systems shall be maintained 15 m/sec(approx.). For rain protection concentric duct to be provided on the top of stack shall be designed such that it restricts rain water entry into stack but allows the gases to move vertically upward with the above mentioned efflux velocity.

9. Generally the following air velocities shall be considered for the dust extraction systems.

At hood inlet          1.5 m /sec (max)
Ducting                18-25 m/sec
10. Suction hood for the dust extraction systems shall not be less than 5 mm thick MS sheet. The ducting shall be of circular cross section.

11. Duct lines shall have cleaning hatches of size 100mm x 75mm with air tight seals for easy cleaning of accumulated dust near bends & inter connections.

12. Horizontal duct shall be avoided as far as possible. Vertical/ inclined ducting shall be provided.

The Successful Tenderer shall include duct supports in their scope as follows:-

a) In-house ducting shall be suitably supported at approx. 3m intervals.

Ducting inside the building shall be supported on the floor or from the column/ civil beam/building structure/technological structure etc. as applicable. The location and type of supporting arrangement shall be decided by the Successful Tenderer in consultation with purchaser/or purchaser’s consultant.

b) Trestle supports shall be provided on ground for the ducting outside the building.

13. The dust extraction system shall be interlocked with the technological equipment/ conveyors. The sequence of operation shall be such that the dust extraction system shall start 5 minutes before start of the technological equipment and shall stop 5 minutes after stoppage of the technological equipment.

14. Dust Disposal System

Dust disposal system including chain / screw conveyors, double cone valve/rotary air lock valve, Dust moistener, dust storage hopper / Rotary feeder etc.

a) Chain Conveyors and Double Cone Valves

b) Chain /screw conveyors and double cone valves will be provided below the dust extraction equipment hoppers for disposal of dust. Chain / screw conveyors will have bearings with outside greasing terminal, protected from dust by packing around the glands. All the vulnerable parts requiring frequent attention will be readily accessible. If two flights of a screw coupled then, overlapping of each flight at center point shall be made for smooth flow of material.

c) Double cone valves will be made of cast iron with the carrying side hard faced. The double cone valve will be complete with shaft of EN8, cast iron housing, geared drive, geared box/geared motor etc.

d) Chain conveyor of following specification will be supplied.

- Forge link chain material = 16 Mn Cr5
- Strength of link (Breaking load) = 20 t.
- Length to suit design requirement
- Hardness of chain link - 55-60 HRC.
- Flight thickness - 10 mm.
- Bottom Plate - IS-2062-A-1999 - 8 mm thick with 10 mm SAIL HARD Liner.
- Side Plate - IS 2062-A-1999 - 6mm thick with 10mm SAIL HARD Liner.
- Top cover - IS 2062-A -1999 - 3.15 mm thick.
e) Zero speed switches will be provided for all dust disposal system drives.

e) Compensator between rotary feeder and the chain conveyors, between two conveyors and between dust moistener and rotary feeder will be provided to facilitate maintenance. Slide gates will be provided before all the double cone dust valves/rotary feeder. For calculation and design of structural members, accidental fill up of dust up to top of hoppers in worst case will be considered by Successful Tenderer.

g) Dust hopper/ Holding hopper

A dust storage hopper for each dust collector cell shall be provided. A pyramidal hopper with 65° valley angles shall be installed to collect the settled dust. The hopper shall have a 2 days dust storage capacity. Rack and pinion sliding gate (motorised) arrangement shall be provided at the hopper discharge. Dust conditioner of double screw type / disc palletizer with controlled moisture addition shall be provided at storage hopper outlet as defined in the Project specific TS. vibrator if required in the hopper is to be provided. Disposal of dust to the closed truck / pneumatic system shall be done through telescopic chute as defined.

h) Rotary Air Lock Valve

Rotary air lock valve shall be made of cast iron with the carrying side hard faced. The rotary air lock valve shall be complete with shaft of EN8, cast iron housing, geared drive, geared box/geared motor.

15. Instrumentation

a) High level/ Intermediate level switch in hopper.
b) Hopper heating units as required.
c) Temperature and pressure transmitter as required,
d) Pressure gauge at inlet and outlet of dust extractor.
e) Differential pressure switch across dust extraction equipment.
f) Master controller and solenoid valve for each module as required.
g) Sequential Timer for bag filter application as required.
h) Compressed air pressure gauge and pressure regulator as required.
i) U – Tube manometer across dust extraction equipment.
j) Continuous pollutants (Particulate matter, SOx, NOx) level monitoring as required.
k) Dry running protection of wet system.

16. Platforms and access stair case

The minimum platform width shall be 1.2 meters. The platforms shall be located at the top of hoppers, level, at the top of the gas cleaning equipment, and at the different levels required for maintenance and operation of the equipment and dampers. A safe guard rail should be provided on the platform. Safe and easy access to the platform shall be provided by providing stairways and railing. Intermediate platforms shall be provided for the bag filters. Following minimum structural member shall be considered.

Hand rail : 25 NB, IS:1239-1990
Operating Criteria

1. As the technological equipment starts dust generation starts at material handling / transfer points.

2. Duct isolation dampers to activate duct routes as per active technological equipment.

3. Adjust the manual butterfly balancing damper connected to the suction hoods for adequate suction of dusty air from all the hoods as per design requirement so as to control the escaping of dusts at the dust generation points.

4. **Electrical Interlocking for starting of dust extraction system:**

   Interlocking to be considered in the MCC to make sure the following sequential starting before the start of technological equipment:

   a) Rotary Airlock Valve/double cone valve.
   b) Activate dust extraction system
   c) Start Fan Motor.
   d) Open Fan Inlet Damper after appropriate time delay of fan motor starting.
   e) Activate duct line Isolation Damper in ducting network to minimise idle suction from non-operating points as per system requirement.

5. In normal condition, switching off operation of DE system should be followed as per following sequence:

   a) Stopping of Technological Equipment
   b) Fan Motor.
   c) Fan inlet damper.
   d) Rotary Air Lock / Double cone valve after appropriate time delay.
   e) Deactivate Dust Extraction Equipment

**Note:** In case the RAL/Double Cone Valve trips the fan motor should also trip to avoid uncontrolled accumulation of collected dust in Dust Extraction Equipment hopper which otherwise may result into choking/clogging of Dust Disposal System.

The Successful Tenderer will examine the above logic and operating principle of the DE system and changes, if any, necessary for trouble free operation of the system being offered by the party shall be indicated.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

11. Type of dust extraction system
12. Total capacity of dust extraction system
13. Make of equipment
14. Design suction quantity
15. Outlet emission quantity
16. Work zone dust concentration
17. Total power requirement
18. Total water requirement
19. Any specific design consideration
20. Noise level at 1m distance from the dust extraction equipment
21. Space requirement (L x B x H)
22. Support / Structure / Weathering shed DE system

13. Dust Disposal Arrangement
Conveyor, Type, nos. capacity tph

- Rotary air lock valve capacity tph & nos.
- Slide gate (Manual)
- Expansion joint at outlet of RAL
- Rotary feeder
- Dust moistener
- Water requirement m3/h at kg/cm2
- Dust bin
- Storage Hopper
  a) Volume in m3
  b) Type
  c) Size (L x B x H)
  d) Motor rating kW & Pole of rack and pinion type discharge gate.
  e) Material / thickness of hopper
- Zero speed switch of drives

14. Instrumentation
Bearing & winding temperature monitor of fan & motor
Pressure transmitter
Temperature transmitter
Level switch
Thermostat for heaters

15. Weight of Dust Extraction Equipment & structure
- Structures
- Dust Extraction Equipment - casing, hopper, internals, Insulation & cladding as applicable, storage hopper, expansion joints & dust disposal equipment
- Fan with drive & accessories
- Duct, suction hood & duct line damper
- Steel stack
- Auxiliary equipment as per job specification requirement
3.0 DUST SUPPRESSION SYSTEM (SS3)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Dust Suppression System with all accessories required to be installed to achieve desired performance in all respect. Specific technical requirement of Dust Suppression System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Dust Suppression System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description Of The Dust Suppression System

There are essentially three types of dust suppression system applied to control pollution in bulk material handling. They are spraying of only water at material transfer points, spraying a solution of water & chemical compound at material transfer points, a dual fluid water and compressed air supplied through nozzle for production of ultra fine water particles, i.e. fog at material transfer points.

02.1 Plain water type dust suppression system

In plain water dust suppression system in general plain water at high pressure is sprayed over stockpile area. This type of system is envisaged for the stockpile area to suppress the generated dust due to stacking / reclamation. Spray water header will be provided along the stockpiles. Dust suppression system is to be designed to prevent lift of dust from stockpiles. Water spray over the stockpile area is produced by sufficient number of sprinklers suitably installed in a header to cover the entire stockpile area. Plain water may be sprayed at transfer station as per job specification requirement.

The sprinklers should be of swiveling type. Each sprinkler operation cycle is to be controlled by a sequential timer to have optimum consumption of water. Water will be stored in a feed water tank. In the supply waterline to feed water tank float valve shall be provided. One additional quick fill line to water storage tank shall be provided. Water from feed water tank shall be supplied to different spray header by a high-pressure pump. Sprinkler post of approx. required height should be installed on the spray header along one/ both side of ores/ coal stockpile area. Before each sprinkler globe valve & solenoid valve shall be provided for manual control and automatic control respectively. The water pump is interlocked with low level switch of feed water tank to prevent the pump from dry running. A pressure switch at the pump discharge line shall be provided to by pass water to storage tank. A solenoid valve in by pass line shall be energized by high-pressure signal from pressure switch.

02.2 Chemically treated water type dust suppression system

Chemically treated dust suppression system work on the principle of agglomeration. Dust particles released from material handling become air borne, are made to pass through a blanket of extremely fine water droplets. The dust particle and the droplets collide and adhere to each other, thus increasing their mass. After a series of such collision the dust particles mass become heavy. The system implies spraying of chemical compound wetting agent and water mixture in certain ratio at each material transfer points. Chemical solution at the pressure of 4 Kg/cm² supplied at the atomising nozzles. The wetting agent (chemical compound) from drum is transferred to solution tank with the help of metering pump (one working and one reserve). Chemical compounds is added in measured quantity in the feed water line to solution tank. The tank is provided with high, low and very low level switch.
There are two-solution pumps (one working and one reserve). Any one of the solution pump can be started if the tank is filled above the low level switch of solution tank and any one of the solenoid valve at spray point is energised. Feed water pump will start when solution level in solution tank reaches low level. Metering pump operation is interlocked with feed water pump. Feed water pump will stop when water level in solution tank reaches high level. In case of very low level in solution tank solution pump will stop. In case of low level in water storage tank feed water pump will stop. A pressure switch at the solution pump discharge line shall be provided to by pass water to solution tank. Solenoid valve in by pass line shall be energised by high-pressure signal from pressure switch. Solenoid valve shall be installed in pipeline in a box at each junction house point to cater solution spray at belt discharge point and belt receiving point. Solenoid valve operation should be interlocked with conveyor motor and load sensor unit. Conveyor motor running under load will draw high current compare to conveyor running under no load. A current transformer located in the power cable circuit will monitor conveyor motor current and shall be interlocked with the operation of solenoid valve.

Chemically treated dust suppression system should be provided for the material transfer points in junction houses.

02.3 Dry Fog Dust Suppression System

The Dry Fog dust Suppression (“DFDS”- water atomization with compressed air) system works on the principle of agglomeration. Water and compressed air are mixed in atomizing nozzles which produces an ultra fine droplets size fog when sprayed and achieve dust suppression though agglomeration. Dust particles released from a material handling or processing plant which becomes air borne, are made to pass through a blanket of extremely fine fog. The dust particles and the micronic sized fog droplets collide and adhere to each other, thus increasing their mass. After a series of such collisions, the mass becomes heavy enough to cause settlement of the agglomerates on to the larger mass of the material being handled.

The System uses an air Driven Acoustic Oscillator Nozzle which is capable of producing supper fine atomization of water droplets that greatly increase the dust particle to water droplet contact resulting in settlement of dust. The fine droplets evaporate before wetting anything but the dust. The approximate water addition is 0.1% of the weight of material being handled.

Description of Scheme

The DFDS system comprising main equipment installed at the application points and auxiliary equipment installed at central water and compressed air supply point. Brief components of both type of equipment are mentioned below:

- **Main Equipment**

  The Main Equipment will include Spray Bar Assemblies fitted with Dual-fluid air Driven Acoustic Oscillator Atomizing Nozzles, Pressure Regulating Units and Flow Activation Stations for ON-OFF Control of the System and Instrumentation for Auto Operation.

- **Auxiliary Equipment**

  The Auxiliary Equipment will include Water Storage and Pumping Unit with duplex Water Filter Compressors with air receivers and Associated Electrical Works, Air and Water Piping, Enclosures etc.
02.4 Elements of dust suppression system

In general following elements specification shall be considered as described in respective equipment specification.

- CENTRIFUGAL PUMP – ES5
- VALVES – ES24

Spray nozzles

Spray nozzles for dust suppression systems shall be of fog-jet type and shall have a solid cone spray pattern with a round impact area and minimum spray angle of 60°.

The nozzles should produce spray distribution of fine sized droplets at the given flow rate and pressure and should provide complete coverage of the spraying area or zone.

The nozzle housing shall be made of cast aluminium alloy and the tip shall be of stainless steel conforming to AISI-410 or SS-304 with SS strainer.

The nozzles should be of self cleaning type with in-built filters made of brass.

Sprinklers

Circular swiveling type sprinklers shall be provided for dust suppression system of stockpiles to spray water and prevent fugitive dust emission.

The brief specification of the sprinklers is as follows.

<table>
<thead>
<tr>
<th>Size of inlet connection</th>
<th>To suit stand-post pipe size and fittings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinkler type</td>
<td>Circular swiveling type</td>
</tr>
<tr>
<td>Material</td>
<td>Cast Iron swiveling arm</td>
</tr>
<tr>
<td></td>
<td>Cast aluminum alloy body</td>
</tr>
<tr>
<td></td>
<td>SS nozzle</td>
</tr>
</tbody>
</table>

This specification specifies general requirement of dust suppression system for different application.

02.5 DESIGN CRITERIA

1. The dust extraction systems shall be such that the work zone dust concentration Respirable Particulate Matter (RPM) less than 10 micron should be limited to 1mg/Nm³ over ambient unless otherwise specified in the job specification.

   i. The capacities of the dust suppression systems shall be selected considering at least 10% for safety over the calculated values.

   ii. Following Indian Standard may please be followed as design guidelines:

       a. IS-638-1979 : Rubber Gasket sheet jointing
       b. IS-800-1984 (RA 1998) : Use of structural steel
c. IS-822-1970 (RA 1997) : Inspection of welds  
d. IS-875-1987 (RA 1997) : Structural design  
e. IS-1239-1990 (RA 1998) : Pipe & pipe fittings  
   Part I & 
   Part II amendment 2000  
   Part I to Part 15  
g. IS-2062-1999 Amendment 2001 : Steel for general structure  
h. IS-2712-1998 : CAF gaskets  
i. IS-11304-1985 (RA 1993) : Air Pollution Control in steel plants  
j. IS-10221 – 1982 (RA 1997) : Wrapping and coating of underground MS Pipe  

iii. The pipelines shall be self balanced without use of valves.  
The Successful Tenderer should calculate and decide the system capacities on their own using the standard norms. However, in no case, the system capacities should be less than as specified in job specification.  

iv. The dust suppression equipment shall be located near to the application area. Approach, handling and hoisting facilities shall be provided for the equipment.  

v. Generally the water line velocity shall be considered for the dust suppression system 0.75 to 1.5m/sec.  

vi. Pipeline shall be of heavy class construction.  
The Successful Tenderer shall include pipe supports in their scope as follows-  
   a) In-house piping shall be suitably supported at approx. 2.5m intervals.  
      piping inside the building shall be supported on the floor or from the column/ civil beam/building structure/technological structure etc. as applicable. The location and type of supporting arrangement shall be decided by the Successful Tenderer in consultation with purchaser/or purchaser’s consultant.  
   b) Outdoor piping may be required to be led through underground trench work with wrapping coating arrangement  

vii. Instrumentation  
   a) High level/ Intermediate level switch in water tanks.  
   b) Pressure gauge at pump outlet of dust suppression system  
   c) Pressure/ flow switch at pump outlet  
   d) Sequence timer for sprinkler operation control as required.  
   e) Load monitoring switch for noting conveyor running on load  
   f) Flow meter at pump discharge line for large DS system or as specified in the job specification.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

23. Type of dust suppression system
24. Total capacity of dust suppression system
25. Make of equipment
26. Design water flow quantity
27. Work zone dust concentration
28. Total power requirement
29. Total water requirement
30. Any specific design consideration
31. Noise level at 1m distance from the dust suppression equipment
32. Space requirement (L x B x H)
33. Support / Structure / Weathering shed DS system
34. List of drive
35. Spray nozzle make rating, quantity
36. Spray nozzle material of construction
37. Sprinkler make, rating, quantity
38. Sprinkler material of construction
39. Load monitoring switch type, quantity and rating
40. Sequence timer type, quantity and rating
41. Solenoid valve type, quantity and rating
4.0 SYSTEM SPECIFICATION OF VENTILATION SYSTEM (SS4)

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Ventilation System with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Ventilation System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Ventilation System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description

Ventilation system shall be provided to maintain proper working conditions environment compatible with human hygienic requirements and to maintain conditions necessary for proper storage of materials and working of plant and equipment. The ventilation system generally include one or more items of equipment and accessories such as fans, air filters, duct work, pumps, air washer, air supply grills, dampers, insulation, instrumentation and controls, electrics, etc.

Ventilation system will be designed considering the climatic conditions prevailing in the region and the plants will generally be installed in separate plant rooms independent of the served premises. The plant rooms will be provided integral with and adjacent to the served premises at proper locations on considerations of convenience of routing of ducts/pipes, availability of fresh uncontaminated air and creating least disturbance to the adjacent premises in terms of vibration and noise.

Ventilation system will be provided with adequate measures for safety and fire fighting for fire hazardous areas and shall be of flame proof/explosion proof construction.

Detail item specification of following accessories for HVAC System is mentioned in the respective Equipment Specification.

- Centrifugal Fan – Reference ES4
- Tube Axial Fan – Reference ES23
- Propeller Fan – Reference ES20
- Ducting network for HVAC system – Reference ES13
- Air Washer - Reference ES2
- Thermal insulation for HVAC Application – Reference ES17.
- Damper – Reference ES10.
- Filter Dry Type – Reference ES15.
- Filter Viscous Oil Type – Reference ES16.

Ventilation facilities

Buildings and shops will generally be provided natural ventilation. Mechanical ventilation will be provided for premises where adequate ventilation cannot be provided by natural means alone. Depending upon the specific requirement, the shops/buildings will be provided with either exhaust ventilation or plenum ventilation. The system design will take into account the requirements of air change as well as excess heat removal. Filters will be provided with plenum systems. By plenum ventilation, the served premises will be pressurised to 2-3 mmWC to avoid ingress of dusty air. Hot

Ventilation facilities for different premises
<table>
<thead>
<tr>
<th>Location/Shop</th>
<th>Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical premises, Switch gear rooms, Cable basements of Electrical sub stations</td>
<td>Pressurised ventilation with or without air washer as per job specification requirement</td>
</tr>
<tr>
<td>Compressed air stations</td>
<td>Exhaust ventilation</td>
</tr>
<tr>
<td>Battery rooms</td>
<td>Exhaust ventilation</td>
</tr>
<tr>
<td>Pump houses</td>
<td>Air cooled type ventilation</td>
</tr>
<tr>
<td>Toilets/Stores rooms</td>
<td>Exhaust ventilation</td>
</tr>
<tr>
<td>Hot working spots</td>
<td>Portable ventilation</td>
</tr>
</tbody>
</table>

Work areas will be provided with portable man-coolers for spot cooling. Man-coolers will be provided also in a few other areas where the premises are manned and have high heat radiation. General details and types of system to be considered is mentioned below. However, specific requirement of ventilation system shall be provided in line with job specification requirement.

The temperature of the Electrical premises and other sub-stations shall be maintained at in the range of 35 ~37 deg C right through the year by the provision of suitable air-cooling system. Air changes for air-cooling system shall be considered minimum 15 and for dry ventilation minimum system 20. Water eliminator in air washer shall be made of PVC.

The temperature of the areas being exhaust ventilated shall not exceed 3 deg C above the ambient at any part of the year.

Following Indian Standard may please be followed as design guidelines:

i) IS-638-1979 : Rubber Gasket sheet jointing
ii) IS-800-1984 (RA 1998) : Use of structural steel
iii) IS-822-1970 (RA 1997) : Inspection of welds
iv) IS-1239-1990 (RA 1998) : Pipe & pipe fittings
   Part I & Part II amendment 2000 : 
   Part I to Part 15 : 
   Part I to Part 15 : 
   vi) IS-2062-1999 Amendment 2001 : Steel for general structure
   vii) IS-2712-1998 : CAF gaskets
   viii) IS-4894-1957 (RA 1994) : Centrifugal fan
   ix) IS-3588-1987 (RA 1994) : Tube Axial Fan
   Part I & Part II : 
   x) IS-8183-1993 (Amendment 1997) : Mineral wool insulation
   xi) IS-2312-1967 (RA 1994) : Propeller fan
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offers.

42. Type of ventilation system
43. Total capacity of ventilation system
44. Make of equipment
45. Design cooling load
46. Indoor climatic condition shall be maintained
47. Total power requirement
48. Air change/hr
49. Total water requirement
50. Any specific design consideration
51. Noise level at 1m distance from the ventilation equipment
52. Noise level at served premises
5.0 **ES1 - AIR HANDLING UNIT/FAN COIL UNIT**

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Air Handling Unit (AHU)/Fan Coil Unit (FCU) with all accessories to make operation of Air Handling Unit (AHU)/Fan Coil Unit (FCU) complete in all respect. Specific technical requirement of Axial Flow Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Air Handling Unit (AHU)/Fan Coil Unit (FCU) is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred for any specific requirement.

02. Description

Air handling units / fan coil units (FCUs)

The Air handling unit / FCU shall be of Fabricated construction, comprising of the following sections:

The air handling unit comprising of fan section, cooling coil section and pre-filter section. The AHU shall be of double skin panel construction. Double skin sandwich panels shall be fabricated from 22 gauge GI sheet. Minimum zinc deposition shall conform to Grade 275 of IS 277,1992. AHU casing shall be thermally insulated with 25 mm thick PUF board in between the outer and inner skin. The unit sections are mounted on galvanized sheet steel channel & aluminium die cast legs. Panels shall be fitted to Al frame work with neoprene gaskets & screws. The framework of AHU casing shall be assembled by means of reinforced nylon corners. The fan section of the casing shall be provided with access door. Aluminium die cast hinges & handles shall be used in access door. Fan impeller shall be of backward curved blade centrifugal type. Impeller shall be of double width double inlet. Impeller blades shall be fabricated from heavy gauge galvanised sheet steel or MS with spray galvanized. Fan rpm shall not be more than 750 rpm. Flexible connection & volume control damper (opposed blade type) shall be provided at fan outlet.

Blower fan shall be statically and dynamically balanced as per ISO1940 Gr 2.5. The first critical speed of the rotating assembly shall be at least 25% above the operating speed. The motor & blower assembly shall be isolated from the main frame by means of spring. Motor & fan assembly shall be mounted on base frame made of aluminium profiles and fixed on antivibration rubber mounts. Motor shall be mounted on a slide rail to adjust the belt tension. Fan shall be coupled to motor by V belts. V belts shall be provided with guards that do not impede the air flow to the fan inlet. Make of AHU fan...
will be Nicorta/ Kruger/ Comferi. Fan static pressure shall be 65 mmwc or more (as required based on pressure drop calculation).

Chilled water cooling coils shall be constructed with copper tubes with fins of aluminium. Thickness of Cu tubes shall be minimum 0.75 mm thick and fins spacing shall be minimum 10 fins per inch. Cooling coil header shall be of GI. Chilled water coils shall be provide with suitable vent and drain connections. Drain pan shall be fabricated from minimum 22 G stainless steel sheet and stainless steel nipple for drain connection. The entire assembly shall be mounted on PUF insulated bottom panel. Condensate drain pipe of required length with sealing loop shall be provided and be insulated. The drain from drain pan shall be connected to floor drain. Air velocity through cooling coil shall not exceed 2.5 m/sec. Water pressure drop through cooling coil shall be limited to 5 mwc. Rows of cooling coil of AHUs shall be 6, however for 100% fresh air application Rows of cooling coil of AHUs shall be 8.

Chilled water flow through AHU will be controlled by 3 way mixing valve. A bypass line around 3 way valves shall be provided. Make of 3 ways valve shall be Honeywell/ Johnson/ Siemens/ Sauter.

Temperature switch and transmitter for monitoring of chilled water and served premises temperature shall be provided.

Fan coil units (FCUs) shall be wall mounted or ceiling suspended type and shall be installed inside the served premises for small isolated cabins/rooms.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer for Air handling unit/fan coil unit.

A. General
   a) Make & Model No.
   b) Type of unit (Horizontal/vertical)
   c) Overall dimensions (mm)
   d) Weight (kg)
   e) Noise level at 1 meter distance in dB(A)
   f) Vibration level
   g) Vibration isolations details

B. Fan Section
   a) Air quantity (m³/hr)
   b) Total/static pressure (mmWC)
   c) Fan speed (RPM)
   d) Fan dia (mm) & number
e) Balancing (Static and dynamic)
f) Fan motor (KW)
g) Type of fan/size/make
h) BHP
i) Type of starter

C. Cooling coil

a) Coil fin materials
b) Tube dia (mm) and thickness
c) Fin size (mm)
d) No. of fins per inch
e) Outside coil surface (m²)
f) Face area (m²)
g) Row deep
h) ADP (deg C)
i) Bypass factor
j) Selected air velocity across coil (m/sec)
k) Make of cooling coil
l) Water through coil in m³/hr.
m) Water velocity through coil in m/sec.
n) Water coil pressure drop in kg/cm²
o) Water temperature in/out in degree C.

D. Filter section Pre filter

a) Type & make
b) Gross filter area (m²)
c) Velocity through filter (m/sec)
d) Pressure drop through filter when dirty & when clean (mmWC)
e) Efficiency
f) Filter box construction details
g) Overall dimensions & No. of filters
h) Fixing frame details
i) Recommended methods of cleaning
6.0 (ES2) AIR WASHER UNIT

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Air Washer Unit with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Air Washer Unit if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Air Washer Unit is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 Description of air washer unit

Air washer unit comprises of intermediate chambers at inlet and outlet, air washing chamber with water tank. The water tank. Adapter section shall be provided for connecting air washer unit with other equipment. Description of these items are given below:

Air washing chamber with water tank

The air washer is used for evaporative cooling of air. The air washer shall be complete with headers, spraying brass nozzles, air distributors, water droplet eliminators, make up water connection with float valve, strainer, overflow connection, quick filling connection, drain connection and other standard accessories. The number of nozzles, size, headers and their disposition shall be suitable for the saturation efficiency of not less than 90% for air washer. The door with viewing port shall be provided for servicing the chamber. The lower portion of the air washer shall serve as tank.

Water of the air washer tank shall be recirculated through pump (1 W + 1 S) & piping network consisting of suction pipes, pot strainers, valves, delivery pipes with branches and spray nozzles etc. The air distributor (perforated plate) shall be provided at the inlet of spray chamber for proper distribution of air to the spray chamber. The PVC droplet eliminator shall be provided at the outlet of spray chamber to arrest/prevent the water droplets from the air going out of the spray chamber. Water loss in the air washing unit shall be filled by the make up water. Make up water from separate source shall be taken to the air washer tank through necessary make up water pipe line with float and globe valves. Another quick fill water pipe line also shall be provided with gate valve for the air washer tank filling. Temperature gauges, pressure gauges, water proof lights, manometer shall be provided at the air washer chambers. Dry running protection of re-circulating pump with water flow switch / tank level switch shall be provided. Drain connections with valves shall be provided for all the three chambers of air washer equipment. The over flow pipe shall also be provided for air washer tank which shall be connected to its drain pipe after/below the valve of the drain pipe.

The casing and tank shall be made of mild steel plate with black bituminous protective paints. The distributor and eliminators shall be made of galvanised sheet steel.

The sheet thickness for air washer tank shall be 6mm and for the body of the air washer shall be 4 mm unless otherwise specified in the TS.
The water proof lights shall be provided inside the chambers of the air washer with lead wiring and switches. Low level switch at air washer tank & interlocked with the re-circulating pump shall be provided.

Air washing chamber shall be provided with drilled flanges at both ends to connect with intermediate chambers on both sides. Rubber gaskets shall be provided at the connection point of intermediate chambers and at inspection window to prevent water leakage.

Water Eliminator shall be PVC baffle arranged such that no water droplets are carried away with the air stream.

The water pipelines shall be of galvanised iron pipes. The nozzles shall be made of brass or gun metal unless otherwise mentioned in the TS.

The face velocity shall not be more than 2.5 m/sec.

Resistance to air flow in washing chamber shall not exceed 15 kgf/m².

The air washer with the tank shall be mounted on a foundation made on the floor of the ventilation room.

Masonry construction air washer chamber may be required to be installed as per job specification requirement.

Intermediate chamber

Intermediate chamber shall be fabricated out of heavy gauge steel sheet (not less than 4mm thick) with drilled flanges at both ends. Water proof light with lead wiring and switches, air-tight door, coupling for installing check instruments, drain connection etc. shall be provided with the intermediate chambers.

Adapter section

Connecting box/ transition piece/ reducer shall connect the intermediate chamber with fan inlet through flexible connection. It shall be fabricated out of heavy gauge steel sheet with drilled flanges at both ends of minimum thickness 3.15 mm.

Supports for intermediate chamber

Triangular leg type (Δ shaped) supports shall be provided on the floor for supporting the intermediate chambers.

01.02 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data air washer unit shall be furnished by the tenderer along with the offer.

a) Air washing chamber with water tank

1. Make & Model No.
2. Type of unit (Horizontal/vertical)
3. Overall dimensions (mm)
4. Weight (kg) with and without water
5. Air flow capacity in m³/h.
6. Air flow velocity
7. Total Pressure drop, kgf/ m²
8. Material of construction, diameter and numbers of spray header pipes
9. Material of construction, diameter and number of nozzles
10. Make up water requirement
11. Details of make up, over flow, drainage, supply and return water pipe lines
12. Saturation efficiency
13. Amount of water and its pressure at the nozzle
14. Material of construction and thickness of casing, tank, air distributor plate
15. Water tank capacity
16. Mounting supports
17. Details of mist /droplet eliminator : material of construction, material thickness and depth.

b) Intermediate chamber

1. Size
2. Material of construction
3. Thickness of material

c) Adaptor section

1. Size
2. Material of construction
4. Thickness of material

d) Re-circulating water system

1. Pump capacity & head, motor KW
2. Re-circulating piping & fitting;
3. Strainer & valve
4. Instruments – pressure gauge, temperature gauge, water flow switch, manometer
7.0 **ES3 - BAG FILTER**

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Bag Filter with all accessories required to be installed for Dedusting System application to achieve desired performance in all respect. Specific technical requirement of Bag Filter System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Bag Filter System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. **Description of bag filter system**

Constructional Features

The bag filter assembly shall generally consist of the following:

- Module shell.
- Hopper for each module with RAVS/Screw conveyor with RAVS.
- Storage hopper with rack & pinion gate valves
- Housing and roof panels.
- Tube plate.
- Compressed air distribution system.
- Access doors.
- Filter bags and cages.
- Inlet and outlet manifolds.

The bag filter shall have a plenum chamber, which distributes the incoming gas onto an array of fabric filter bags. Dust particles shall be entrapped on the filter fabric, cake lining the bag surface by straining, impingement, interception and electrostatic attraction. Rotary air lock valves shall be provided at the bottom of bag filter hopper for dust removal and air sealing.

Normally bag filter casing thickness shall be 5 mm with sufficient stiffener to withstand design static pressure inside Bag filter chamber.

The inlet air plenum for the fabric filter should feature a tapered feed duct in order to ensure uniform gas flow distribution to all cells.

Air entry to the cells should be directed uniformly by angles deflection louvers to ensure complete bag usage within the cell. Cross horizontal flows shall not impinge on the bags in any area.

The bag fixing arrangement shall be such so as to enable easy and quick changing of bags.

Bags shall be hung as near as practicable to vertical so that the bags are not touching anywhere along their length. The Bag filter shall have antistatic Bags and spark proof design for the coke/coal application.

Particular attention shall be paid to the layout of the bags. A minimum distance of 75 mm between the bags and the closest fabric surface such as walls or columns of the casing shall be provided. The spacing between the bags shall be 50 mm (minimum).
### Required Air/cloth ratio

The contractor should design the pulse-jet fabric filter dust collector to operate under design flow conditions with a gas/air to cloth ratio as 1.4 m³/ min/m² unless otherwise specified in the project specification. However, the same can vary from 1.0 to 1.8 depending on fabric and dust material to be handled.

### Bag Cleaning

The bag filters shall be of on line / off line cleaning pulse-jet type as specified in the job specification. Material of construction of bags shall be selected based on operating temperature, dust quality, quantity and composition and air quality. The cleaning of bags shall be carried out in a predetermined cycle by high-pressure pulse of compressed air by automatic operation of solenoid valve with timer.

A differential pressure measurement system shall be provided across the bag house. As the dust collects over the bags, the pressure drop shall be sensed by this system. As this drop exceeds a preset value the differential pressure measurement system shall send a pulse to start the bag cleaning operation.

Compressed air shall be the cleaning medium and this shall enter the bags in short surges thus inflating the bags. The dust shall collect in the hoppers provided and shall be transferred by conveyor/ RAVS to holding hopper. In general centralized Compressed air network with air drier shall be provided to ensure supply of dirt and moisture free compressed air for bag cleaning as per job specification requirement.

The successful tenderer shall supply compressor along with drive and accessories safety valve, pressure gauge, air filter cum moisture separator unless otherwise specified in the job specification.

### Dust hopper/ Holding hopper

A dust storage hopper for each fabric filter module shall be provided. A inverted pyramidal hopper with 65° valley angles shall be installed to collect the settled dust. Vibrator if required in the hopper is to be provided. For hot gas cleaning system hopper heater with thermal insulation shall be provided to reduce chance of condensation in hopper. Normally storage hopper thickness shall be 8mm unless defined in the TS.

### Platforms and access stair case

The minimum platform width shall be 1.2 meters. The platforms shall be located at the top of hoppers, level, at the top of the gas cleaning equipment, and at the different levels required for maintenance and operation of the equipment and dampers. A safe guard rail should be provided on the platform. Providing stairways and railing shall provide safe and easy access to the platform. Intermediate platforms shall be provided for the bag filters. Following minimum structural member shall be considered.

- **Hand rail**: 25 NB, IS:1239-1990
- **Post**: 32 NB, IS:1239-1990
- **Access grating**: 40 depth, 6 thick,
- **Stair**: 40 C/C, 38° slope
Electrics For Bag Filter System of Each DE System

The Electrics for bag filters of D.E. system will consist of pressure switches cum indicator in the compressed air line, differential pressure switches, solenoid valves, control panel and all other associated equipment. The brief specification of the major components will be as given below:

**Control panel for Bag filter**

The control panel will be free standing, floor mounting, fabricated from 2.0 mm thick CRCA sheet steel on a base channel of size 77 mm x 40 mm (ISMC - 75) provided with cable gland plates, having synthetic rubber gasketting, provided with double door & canopy and enclosure conforming to IPW-55. The control panel will be factory assembled, wired with 1.1 kV grade PVC flexible wire of copper conductor (minimum size 2.5 sq.mm), factory painted. The control panel will be provided with following major equipment:

a) **Incoming switch (minimum 32A, AC23 duty) with operating handle interlocked with the door, HRC fuses, contactors, MCBs in the various circuits.**

b) **Control transformer of required VA rating having +/-5 percent and +/- 2.5 percent tappings in the primary side of the control transformer with Isolating switches/MCBs in the primary & secondary sides.**

c) **24V DC full wave power pack complete with filter and protective elements and also isolation cum short circuit protection both at AC and DC sides for power supply to solenoid valves.**

d) **Auxiliary contactor for control power supply monitoring, interlocking, and controls etc.**

e) **Auto-manual selector switches, push button switches, indication lamps, various monitoring devices, terminals (with 20 percent spare terminals) and other circuit elements required for control and monitoring.**

f) **Solid state Bag filter timer.**

The bag filter timer will be solid state device suitable for dusty, tropical and specified aggressive environment. The bag filter timer will be provided with internal semi-conductor fuse protection and will have provision for pulse frequency setting and pulse duration setting through independent operating knobs. The number of contacts in the timer will be equal to number of solenoid operated valves so that the timer will energise only one solenoid valve at a time and shall operate in sequence.

The Bag Filter Timer will provide timed sequential energisation of 24V DC operated solenoid valves of bag filters. LEDs for each solenoid energisation, power ON in PCB, feed back relay will be provided with potential free contacts which will close under following conditions:

i) **Fault in the PCB.**

ii) **Open contact in the output side connected to individual solenoid valves. The contact will not close in the event of power failure to the controller.**

iii) **The sequential control (i.e. process) will start when the Differential Pressure (DP) switch is actuated at the first set point for normal operation. The process will continue till the pressure differential drops below the set value. When again the DP**
switch is actuated the process will continue from the previous position (i.e. next solenoid valve). However, when the power supply to sequential controller trips, the process will stop and sequential controller is reset to first load position enabling the process to start from the beginning.

iv) Sufficient space will be provided for installation of bag filter panel with required front clearances for operation and maintenance including side and back clearances as required.

**Differential Pressure Switch**

i) The differential pressure switch will have two sets of independent micro-switches. The first set will be used for normal sequential cleaning operation of the bag filters as per lower set value of differential pressure. This set point will be independently adjustable.

ii) The second set of N.O. contact will close at upper set value of differential pressure representing clogged condition of bag filter and will be used for signaling and monitoring. This set point will also be independently adjustable. The contacts will be rated for 5 Amp, 240V AC.

iii) The DP switch will be suitable for outdoor installation. The DP switch casing will be made of pressure die cast Aluminum with enclosure conforming to IP-66.

iv) One number differential pressure switch with two set points will be provided for each module of the Bag filter. Alternatively, two numbers of DP switches may be provided for each module one for initiation of bag cleaning operation and other for signaling and monitoring of clogged condition.

v) Manometer across filter.

**Solenoids**

i) The solenoid coil will have encapsulated coil (class F’ insulated with a water proof (IP-65) plug-on connector. The coil will be suitable for 24V DC having +10 % to -15 % voltage variations. The coil will be made of copper conductor.

**Air Pressure Switch cum indicator**

i) One number compressed air pressure switch cum indicator will be provided for each bag filter system in the incoming compressed air pipeline of the bag filter. The pressure range will match with the operating pressure. The switches will be snap action type with 1 NO + 1 NC contacts of 5A, 240 V AC. These contacts will be wired up to terminals in the bag filter control panel. The enclosure of the air pressure switch will be pressure die cast aluminum conforming to IP-65.

**GENERAL ELECTRICAL LOGIC AND OPERATING PRINCIPLE OF THE BAG FILTER SYSTEM**

A. Mainly the differential pressure will govern the Dedusting Bag Filter system across the Dedusting Modules.

The total electrical logic will be controlled by the Devices like Differential Pressure Switch (DPS), solid-state sequential multi channel timer, solid-state master card, solenoid operated Diaphragm valves, inlet compressed air line pressure switch (P.S.) etc. DPS will be connected across the clean and dirty Air Chamber of the Bag Filter Module to measure the Pressure
Differential. As the Filtration process commences, there is a gradual build up of dust on the Filter Bags which generates Differential Pressure. When this Differential Pressure attains a Pre-set value based on inlet dust concentration, type of dust and its particle size distribution, the differential pressure switch will get energized and send signal to the master card located in the control panel.

The master card will actuate the timer whose channels are connected with solenoid valves mounted on the compressed air header-Air Manifold Tank. Through the timer, the solenoid coil gets magnetized and makes an opening for the compressed air to flow from air manifold tank to pulse header pipe.

The pulse duration time will be adjustable. During this time the solenoid coil will remain energised allowing pulse air to flow. Energisation of other solenoid will take place in sequence one after the other. The time gap between the two-solenoid energisation will also be adjustable.

The process continues till the pressure differential drops below the set value. The D.P. Switch then gets de-energised which in turn cuts off the timer resulting in de-energisation of solenoid valves. The process will repeat again from the next solenoid valve based on the pressure differential switch and signal from the master card.

A pressure switch mounted on the compressed air line will sense the available pressure and dedusting system/centrifugal fan will switched off in case the available pressure falls below the specified pressure in compressed air line.

B. Following sequential steps of operation will be followed before actually switching on the main technological equipment to be dedusted:

1) Screw conveyor drives along with rotary air lock drive will be started first.

2) a) Setting differential pressure in differential pressure switch at the initial time of commissioning and for re-commissioning after long gap with clean Filter bags.

b) Power to timer to be switched ON

3) Fan motor to be started in the inlet Damper closed condition. After appropriate time delay fan inlet damper to be opened.

DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:-

The tenderer along with the offer shall furnish the following data:

Bag filter

1. Make, type and quantity
2. Model No.
3. Type of bag filter
4. Capacity in m³/hr
5. Filtering area in m²
6. Fabric type
7. No. of bags
8. Diameter & length of bags in mm
9. Filtering velocity m/sec.
10. Pressure drop in mm WC
11. Weight of bag filter in kg (without dust)
12. Weight of bag filter in kg (with dust)
13. Efficiency of bag filter Vs particle size
14. Material / thickness of bag filter casing in mm.
15. Material / thickness of bag filter hopper in mm.
16. Compressed air requirement m$^3$/hr.
17. Compressed air pressure
18. Compressed air quality
19. Velocity of air at inlet / outlet in m/sec.
20. Fixing arrangement of filter bags
21. Space requirement (L x B x H)
22. Rotary Air Lock Valve details
   a) Quantity
   b) Capacity in m$^3$/hr (at 50% filling)
   c) Speed in rpm
   d) Motor rating kW & Pole.
23. Storage Hopper
   f) Volume in m$^3$
   g) Type
   h) Size (L x B x H)
   i) Motor rating kW & Pole of rack & pinion type discharge gate.
   j) Material / thickness of hopper
24. Support / Structure / Weathering shed for bag filter
8.0 ES4 - CENTRIFUGAL FAN

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of Centrifugal Fan required to be installed for HVAC, Dust Extraction, Combustion System process application with all accessories to achieve desired performance. Specific technical requirement of Centrifugal Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of different type of Centrifugal Fan is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 Description of Centrifugal Fan

Generally the fans shall be of limit load design. Centrifugal Fan design shall conform to IS 4894 – 1987 (Reaffirmed 1991).

The fan shall be of rugged steel construction, industrial duty type and suitable for the proposed project/plant. Fan housing shall be of welded construction and provided with flanges at inlet and outlet sides for duct connections.

The fan unit shall be free from undue noise and vibration during operation; normally the fan speed shall not be more than 1500 RPM, preferably less than 1000 RPM.

The fan shall be both statically and dynamically balanced as per ISO:1940. In general HVAC system application balancing grade shall be of 6.3 and for process application balancing grade shall be of 2.5.

The fan impeller may be backward curved / backward inclined/forward curve/radial job specification as per requirement.

Drain connection shall be provided at the lowest point of scroll.

Fan bearing shall be of self aligning, heavy duty type. Bearing shall be selected with ample safety factor for longer life.

Sufficient number of suitable vibration isolators of approved make shall be provided to ensure isolation of vibration from the equipment to foundation as per requirement.

Fabricated steel bracket of M.S. angles, channels and chequered plates shall be provided to take static and dynamic load of the fan and motor assembly.

Electrically operated / manually operated inlet vane damper shall be provided as a regulating device for control of fan flow volume as per TS requirement. The air stream shall be caused to rotate through alteration of the pitch of guide vanes.
Manually/electrically operated fan outlet damper shall be provided as per TS requirement.

Fan inlet and outlet flexible connections shall be provided as per TS requirement. Guide plate shall be provided to prevent direct contact of flexible fabric with air flow.

Anchor bolts, nuts, foundation plates etc. as required shall be supplied with the equipment. The equipment shall be designed to permit ease of access during inspection, maintenance and repair.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed.

The housing shall be provided with lifting eye for ease of handling and bolted type access door.

The noise level of fan shall not exceed 85dB(A) at a distance of 1 m when running at full load. Material of construction, capacity and static pressure of fan shall be as per TS requirement.

The fan shall have following minimum thickness of materials for different parts unless otherwise specified in TS for HVAC application:

a) **Capacity below 20,000 m³/hr :**
   
   Casing : 3.15 mm  
   Back plate : 4 mm  
   Impeller : 2.5 mm

b) **Capacity above 20,000 m³/hr and below 50,000 m³/hr**
   
   Casing : 4 mm  
   Back plate : 6 mm  
   Impeller : 3.15 mm

c) **Capacity above 50,000 m³/hr upto 1,00,000 m³/h**
   
   Casing : 6 mm  
   Back plate : 8 mm  
   Impeller : 6 mm

However for different process application depending upon specific requirement material of construction shall be defined in TS.

The fan shall be provided with drive motor, drive coupling/V-belt, belt pulley, belt guard, fan inlet and outlet flexible connections, variable inlet vane, fan outlet damper, slide rails, foundation plates, gaskets, base frame, vibration isolators, foundation bolts and nuts, fan inlet protection screen and other standard accessories unless otherwise specified in the TS. All these items/materials and accessories shall be supplied with the fan.
DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:-

The following data shall be furnished by the tenderer along with the offer.

a) CENTRIFUGAL FAN

1. Make & Model No.
2. Quantity, no.
3. Type of blade
4. Capacity, m³/h
5. Static pressure and total pressure, mm WC
6. Operating speed, rpm
7. Critical speed, rpm
8. Shaft power, kW
9. Total Efficiency, %
10. Motor rating, kW/ pole
11. Fan Characteristic Curves
12. Impeller Diameter in mm
13. Impeller weight in kg.
14. GD² value
15. Velocity at inlet & outlet of fan, m/sec
16. Static weight & dynamic weight of fan and motor, kg
17. Coupling details/V-belt details
18. Vibration level
19. Vibration isolator type & quantity.
20. Outlet damper size
21. Material of construction & thickness of scroll, blade, shroud, back plate, shaft diameter in mm
22. Noise level at 1m distance in dB(A)
23. Bearing details
24. Acoustic lagging / silencer, if included :
   i) Material of construction
   ii) Insertion loss

25. Overall size
26. Drive Motor rating suggested
27. Special constructional feature, if any

a) FAN DRIVE MOTOR DETAILS

1. Type & make
2. Voltage, phase & frequency
3. Rated power, kW
4. Speed, RPM
5. Starting/ pull out torque
6. Starter details
7. Line current
8. Starting current
9. Overall efficiency
10. Class of insulation
11. Type of enclosure
12. Any other information
b) VIV Damper

1. Make, model and type
2. Diameter of VIV
3. Type of actuator, if applicable
4. Motor kW/pole
5. Material of construction and thickness
9.0 ES5 - CENTRIFUGAL PUMP

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, testing and supply/fabrication of Pumps with all accessories required to be installed to achieve desired performance in all respect. Specific technical requirement of Pumps if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Pumps is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned under clause No. 03.

02 Pumps

The pumps shall be designed, manufactured and tested as per IS:1520-1980 (R.A. 1993), IS:5120.1977 (R.A.1997) Amendment 2000, IS:9137-1978 (R.A. 1993), IS6595-1993 (Part II) or as per other international standards acceptable to the Purchaser and shall be suitable for the duty conditions and capacities as indicated in this specification.

The centrifugal pumps along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and manufactured for continuous duty at full load.

All the pumps shall be capable of developing the required total head at rated capacity for continuous operation. The pumps shall operate satisfactorily at any point on the H-Q characteristic curve over a range of 50% to 130% capacity or capacity corresponding to 75% of the total head whichever is lower.

Capacity vs discharge pressure curve for each pump shall preferably be continuously drooping from the shut-off point to the rated operation point and be suitable for parallel operation. The pumps shall be designed to avoid cavitation at any of the operating points.

The required duty range for a pump shall be on stable portion of its head-capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge.

The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantled without disturbing the suction and delivery pipe connections.

The equipment design shall incorporate provisions for reduction in noise level.

The rotating elements of the pumps shall be checked for critical speed in bending as well as torsion. The critical speeds shall be at least 30% away from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating speed in case of stiff shafts.

All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

All pumps preferably shall be horizontally split type with maximum RPM of 1,500. However, very small pump of capacity less than 15 m3/h for air
A stainless steel name plate of 2 mm thickness shall be provided and securely attached by stainless steel pins at an easily accessible point on the pump. The plate shall be stamped with the following minimum information:

- DESIGN CAPACITY
- TOTAL HEAD
- SPEED
- MOTOR RATING
- MODEL NUMBER
- MANUFACTURER’S SERIAL NUMBER
- WEIGHT OF EQUIPMENT
- TAG NUMBER

The total head-capacity curve shall preferably be continuously rising towards the shut-off. The shut-off head shall be at least 110% of the total head.

The required NPSH at duty point shall be at least 1.0 m lesser than the available NPSH.

The velocity of vibration shall be within 4.5 mm/sec.

The power rating of the pump motor shall be larger of the following:

- 110% of the power required at the duty point.
- For parallel operation, motor rating should be sufficient enough for running of single pump also.

The common base frame for pump and motor shall be in one piece with suitable holes for grouting. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15mm drain piping. Pumps shall be supplied with suitable drain pans or drain rim type base plates with valved drain connections.

Coupling guard, made of expanded metal and bolted to the base plate shall be supplied for all pumps.

Pumps will be supplied with flexible coupling. Back-pull out type pump shall be provided with...
spacer type coupling.

Standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the maximum discharge head or twice the rated discharge head whichever is higher. The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.

Casing

The casing shall be of cast iron and shall be designed for a pressure not less than the shut-off pressure at the highest operating speed plus the maximum pressure that may be encountered at the pump inlet. In addition, CI casing shall have corrosion allowance of not lower than 3 mm.

Impellers

Impeller shall be of bronze. Impellers and balancing drums (if provided) shall be statically and dynamically balanced. Dynamic balancing shall be at the operating speed of the pump. For multi stage pumps, all the impellers shall be assembled together for balancing. Provision shall be made for adjusting the clearance between the impeller and the casing to compensate for wear.

The impeller shall be keyed or screwed on to the shaft in such a way that it does not come-out due to reverse rotation of the pump.

Shaft

The shaft shall be of EN-8 or C-40 or equivalent and shall be designed for critical speed. The ratio of critical speed to speed of shaft shall be not less than 1.3 for solid shafts.

The deflection in line shaft shall not exceed 1 mm per meter of length. All shafts above 150 mm diameter shall be ultrasonically tested. Shafts shall be checked for endurance and strength. Change of sections in shafts if considered shall be made with due allowance for stress concentration. Shafts shall be machined to close tolerance for mounting on impeller bearings, shaft seal, shaft sleeve, shaft coupling etc. The magnitude of shaft deflection at the face of the shaft seal shall not exceed 50 microns.

Coupling and coupling guard

Horizontal pump sets shall be provided with flexible couplings of pin and bush type and shall be constructed of metallic materials except for bush which shall be of rubber materials. Coupling shall be properly keyed in place and the cylindrical fit shall allow simple removal of the coupling in the field.

Removable coupling guards shall be supplied and mounted. Guards shall be sufficiently heavy and rigid to provide adequate personnel safety.

Shaft sealing

Shaft seals shall be provided to prevent leakage out of, or into, a pump over the range of specified operating conditions. The seals shall be suitable for variations in inlet conditions that may prevail during start-up and shut down. They shall be accessible for inspection and replacement without disturbing any part of the installation.
**Bearing**

Two bearing assemblies shall be provided, one within the frame to carry radial load only and the other to carry both radial and axial thrust. Bearings shall be of manufacturer standard design, antifriction type, oil / grease lubricated. Suitable thrust bearings shall be provided in the pump to take total thrust of the pump including hydraulic thrust. Thrust bearings shall be of oil lubricated type with suitable cooling arrangement. Motor thrust bearing shall be designed without water cooling arrangement. Suitable tapped holes shall be provided for refilling of oil in the bearing housing.

All the vertical pumps shall be provided with separate thrust bearings with proper lubrication and cooling facilities as required so that the thrust and other vertical loads due to the moving parts are not transferred to the prime mover.

**Base plate**

All horizontal pumps shall be supplied with sturdy base plates of manufacturer’s standard, common to pump and drive. Base plates and pump supports shall be constructed so rigidly and the unit so mounted as to minimize misalignment due to piping strain, internal differential thermal expansion, etc. Base plates shall be fabricated from MS channels.

**Companion flanges, bolts, nuts & gaskets**

Plate flanges having raised face shall be provided at suction and delivery side of pumps and they shall be of mild steel and conform to table 17 of IS: 6392-1971 (R.A.1988). Slip on raised face flanges to 150 Lbs. class conforming to ANSI B16.5 shall also be acceptable.

Black bolts and nuts conforming to IS 1362-1992 shall be provided for the companion flanges.

CAF gaskets of 1.5 mm thickness conforming to IS: 2712-1979 (R.A. 1994) shall be provided for the companion flanges.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:

The following data shall be furnished by the tenderer along with the offer.

1. Make and model no.
2. Type of pump
3. Capacity in m³/hr.
4. Total head in m WC
5. Quantity
6. Material of Construction of
   - Shaft
   - Impeller
   - Casing
7. Pump speed (rpm)
8. Shaft power
9. Drive details
   - Motor make
   - Motor kW
   - Class of insulation
   - Frame size
10. Bearing type & make
11. Type of coupling
12. Vibration level
13. Noise level at 1 m distance
14. Duty
15. Weight of pump & motor separately
16. Characteristic curves for pumps
17. Type of liquid to be handled
10.0 **ES6 – VAPOUR ABSORPTION M/C (VAM)**

The VAM based chilled water plant shall include

- Vapour absorption machine(s) with accessories
- Hot well pumps (1w +1s)
- Cold well pumps (1w +1s)
- Condenser water pumps (1w+1s)
- Induced draft counter flow FRP cooling tower with RCC basin & PVC fills. Cooling tower basin shall be at higher elevation than the condenser water pump.
- Steam piping (from battery limit onwards) along with all necessary valves (shut off valve, flow control valve etc.), instruments & safety devices. IBR approval are in the scope of tenderer.
- Steam pressure & temperature control system.
- Steam condensate disposal arrangement. Steam condensate line shall be of SS
- Chilled water/ condenser water piping.
- Valves/ strainers etc in pipe lines
- Thermal insulation of chilled water pipes and steam pipelines.
- RCC hot well tank & cold well tank. Insulation of tanks. Tanks shall be located at the top most location of the entire chilled water piping network.
- MCC, starter panel, electrics, instrumentation etc.

VAM shall be completely factory assembled and wired in a single package complete with evaporator, absorber, two stage generator, condenser, heat exchangers, solution pump, refrigerant pump, vacuum pump for purging, starter panel (starting control), micro processor control panel (safety & operating controls) , all necessary sensors/ instruments, internal cabling and piping work.

VAM shall be supplied with full operating charge of refrigerant (water) & lithium bromide solution (with non toxic inhibitor) and shall be factory tested under operating conditions.

Automatic control of chilled water outlet temperature by controlling steam flow rate.
VAM shall have connectivity for communication, data logging, history charts, mimics to PC at remote location.

M.O.C of all the heat exchangers tubes shall be of Cu (70%) -Ni (30%) & seamless.

Solution & refrigerant pump impeller shall be of SS & drive shall be hermetically sealed.

Insulation of VAM unit.

Fouling factor for condenser & evaporator shall be considered 0.001 & 0.0005 hr-ft $^{2}$ O F/ Btu respectively

Purchaser will make available steam at 8 Kg/cm2 (g) pressure.

Vapour absorption m/c shall be chosen not only to meet the full load design, but also to perform efficiently at lower loads and at lower condenser water inlet temperature (particularly during winter season). If needed condenser water temperature control shall be provided. Tenderer shall furnish the inlet condenser water temperature range of their machine.

Evaporator heat exchanger design shall meet the chilled water inlet & outlet temperature required for process cooling.
11.0 **ES7 - CENTRALISED HVAC SYSTEM VAPOUR COMPRESSION BASED**

**01 General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of Direct Expansion (DX) type / Chilled Water generator equipment with all accessories required to be installed for HVAC and process cooling purpose to achieve desired performance. Specific technical requirement of Direct Expansion (DX) type / Chilled water generator type equipment if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of different type of Direct Expansion (DX) / Chilled Water generator Type Equipment is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

**02 Description**

1. **Base Frame:**

   Water chilling package base frame structure will hold the following:
   
   A. Reciprocating / centrifugal / screw refrigeration compressor
   B. Condenser
   C. DX water chiller
   D. Associated refrigerant piping, fittings and controls.

   Normally Water chilling package shall be of floor mounted two tier type.

   Direct Expansion (DX) type frame structure will hold the following:
   
   A. Reciprocating / centrifugal / screw refrigeration compressor
   B. Condenser
   C. Associated refrigerant piping, fittings and controls.

   Resistoflex neoprene pads shall be used as vibration isolator between common base frame and floor and spring cup type vibration dampers shall be used between compressor and common base frame.

2. **Refrigeration compressor**

   Refrigeration compressor shall be of multi cylinder reciprocating / centrifugal / screw type. The compressor shall be driven by TEFC motor through V-belt drive/flexible coupling direct drive. Compressor design shall conform the required safety measures as per IS-11461-1985 guide lines and testing of compressor shall confirm to IS-5111-1993.

   The chiller shall be supplied with full operating charge of refrigerant R-22/ R-134a & lubricating oil. Chiller performance shall be ARI certified as per ARI standard 550-92. Cooler (evaporator) shall be dry expansion type.

   Compressor housing cylinder head shall be of fine grained cast iron. Valve plates shall be of cast iron or stainless (ring plate type). The piston shall be made from light metal.
alloys preferably Aluminum with one oil groove and two compressor rings. The connecting rod shall be of forged steel of Aluminum alloys with integral bearing surfaces on crank and piston pin ends. Crank shaft shall be of forged steel with drill for oil distribution. Crank shaft shall be statically and dynamically balanced to eliminate vibration. In case of shaft seal, the same shall be positive acting to prevent the leakage of refrigerant and infiltration of air during compressor operation and idle periods.

The main bearing shall be of self-alignment, horizontally split and lined with anti-friction bearing metal.

Compressor shall be lubricated by forced feed lubrication system comprising of reversible, positive displacement gear type oil pump, interconnecting pipes, filter cartridge, oil strainer, sight glass, oil drain valve. If required, oil coolers shall be provided. Oil safety switch shall be provided to stop the compressor in case of excessive or lower oil pressure.

The refrigerant compressor shall be equipped with built-in automatic unloaded starting arrangement.

Electrically operated crankcase heaters suitable for specified power supply system shall be provided. Heaters shall be automatically actuated when compressor is stopped.

The compressor shall have automatic capacity control in addition to manual capacity regulation. Capacity regulation shall permit the operation of the compressor at part load with reduced power consumption.

The following accessories and instrumentation shall be considered for the refrigerant compressor:

A. Large suction strainer, muffler.
B. Service stop valves for suction and discharge sides.
C. Pressure and temperature gauges for suction, discharge and lubricating oil.
D. Common base frame for compressor and motor including Coupling.
E. Flexible coupling/V-belt drive.
F. Coupling belt guard.
G. Crank case heater.
H. Oil chargers and oil check valves.
I. Electric motor, drive set.

The following controls and safety devices shall be provided for the compressor:

A. Oil safety switch.
B. High and Low pressure cut outs
C. Relief by pass valves.
D. Spring loaded, built-in safety valves for each cylinder.
E. Indicating lamps and alarms.
F. Timer to set time interval between starting and loading the compressor.

3. Condenser
The condenser shall be of horizontal, shell and tube type construction with water flowing inside the tubes and the refrigerant gas condensing outside the tubes. Alternatively as per job specification requirement air cooled type condenser may be provided. Condenser design shall confirm to IS-11327-1985 guidelines.

The condenser shall be equipped with integral finned type, solid drawn, seamless copper tubes.

Multi-pass construction condenser shall be provided. It shall be designed for proper number of passes to give optimum water velocity, efficient heat transfer and allowable pressure drop.

The condenser tubes shall be rolled into the grooves of tube sheets at either end to ensure a perfect water and air tight joint.

Adequate baffling arrangement shall be used in the condenser for improved heat transfer.

Condenser tubes shall be adequately supported to prevent sagging and vibration failure.

The joints of water boxes and tube sheets shall be water tight while those of tube sheets and shell are air tight to prevent leakage of refrigerant and infiltration of moisture into the system.

The condenser shall be equipped with following accessories/safety devices:

A. Purge valve
B. Charging valve
C. Relief valve/fusible plug
D. Hot gas inlet/liquid outlet connections or the shell with flanges.
E. Water inlet/ outlet connections with flanges.
F. Hand shut-off valve for water inlet and outlet to condenser and chiller.
G. Pressure and temperature gauges for water inlet and outlet/refrigerant gas inlet and outlet.
H. Vent valves etc.
I. Charging valve.

Chemically treated water shall be considered as make-up for condenser cooling system. Necessary water treatment / softening plant shall be considered by the successful tendered

4. Chiller

The chiller will be of direct expansion, horizontal, shell and tube type construction with the refrigerant flowing inside the tubes and the water outside the tubes.

Chiller shall have MS fabricated shell, copper tubes with internal turbulators and MS tube sheet and MS fabricated or cast iron shell end boxes. The shell shall be designed for approximately 10 kg/cm².

The copper tubes shall be rolled into grooves on tube sheets for a water and airtight joint. Joints between the tube/sheets and the shell should be watertight while those
between the shell and the boxes should be airtight. Adequate sealing gaskets should be used to prevent leakage of refrigerant and the infiltration of moisture and air into the system.

The chiller shell shall have flanged water inlet and outlet connections welded as an integral part of it.

The chiller assembly will be thermally insulated with polyurethane or equivalent material of adequate thickness and finished as described under 'Insulation'.

Chiller shall be equipped with the following controls/accessories/safety devices:

A. Refrigerant liquid inlet and gas outlet connections with flanges and liquid line, shut-off valve,
B. Liquid distributor with proper circulating arrangement,
C. Thermostatic expansion valve,
D. Solenoid valve on liquid inlet line,
E. Cooling and anti-freeze thermostats,
F. Water inlet/outlet connections with flanges and shut-off valves, along with counter flanges.
G. Vent connections with valves,
H. Pressure and temperature gauges at the water inlet/outlet.
I. Relief valve, purge valve, drain valve, shut-off valve,
J. DP switch across the chiller.

5. Interconnecting refrigerant piping, fittings and valves

Refrigerant piping is required to interconnect the compressor, condenser and the chiller into a closed network.

Expansion valves shall be pilot operated type. Solenoid valve shall be provided for 'Pump down' operation of the unit.

Moisture indicators, filter/drier unit shall also be provided in the liquid line with isolating valves.

Strainers shall be of brass, complete with bronze screen and permanent magnet strainers shall be installed up-stream of refrigerant solenoid valves, as per requirements. Strainers shall be provided with isolating valves and valves bypass.

Heavy duty seamless steel pipes shall be used for the piping network; while seamless solid drawn copper tubes shall be used for the refrigerant liquid line.

The piping network shall incorporate loops in the circuit to efficiently separate oil and liquid refrigerant from the gas and suction vapour respectively.

All horizontal lines shall be pitched to 12 m for every 3 meters in the direction of refrigerant flow. All necessary loops and bends shall be provided to ensure proper return of oil to the Compressor. All the piping shall be adequately supported and isolated by means of suitable vibration isolators.

Suction line shall be thermally insulated with polyurethane or equivalent material of adequate thickness.
The following accessories/controls shall be provided for the refrigerant piping:

A. Liquid line strainer/drier,
B. Liquid to suction heat exchanger,
C. Hand shut-off valves,
D. Sight glass etc.

All the piping network shall be pressure tested, leak tested, dried, evacuated and charged with the refrigerant after erection.

6. Controls & Instruments

• Pressure gauges

Pressure gauge shall not be less than 150 mm diameter dial with appropriate working range and be complete with shut off gauge cocks etc., duly calibrated before installation. Pressure gauges shall be provided at the following location.

A. Supply and return of Chillers and Condensers.
B. Discharge of pumps.
C. Inlet and outlet of heat exchangers.
D. Supply and return chilled water line of A.H.U.

In refrigerant line suction side gauges shall be compound gauges of the range 0-75 mm (0.3") mercury vacuum and 4 kg/sq. cm positive pressure. Discharge side gauge 0-6 kg/sq cm pressure. Gauge shall be connected to pipe by 6 mm dia copper tubing through 6 mm dia shut off cocks.

• Thermometers

Thermometers shall be 150 mm dial type with capillary tube and protective sheets, duly calibrated before installation.
DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:

The following data shall be furnished by the tenderer along with the offer.

1. Refrigerant Compressor
   
   a) Manufacturer
   b) Model No.
   c) Refrigerant
   d) Capacity at operating conditions
   e) Maximum speed/operating speed
   f) BHP at operating conditions
   g) BHP/TR at operating conditions
   h) BHP consumption

   100% load
   75% load
   50% load

   i) Types of controls offered and make
   j) Motor

   Make:
   Type:
   Rating (KW) and rpm:

   k) Starter: Make & Type
   l) Capacity control
   m) Lubrication
   n) Total weight
   o) Noise level at 1 meter distance in dB(A)
   p) Vibration level
   q) Vibration isolators details

2. Condenser
   
   a) Manufacturer
   b) Shell diameter and length (mm)
   c) Tube material
   d) Fouling factor
   e) No. of tubes
   f) Tube diameter (mm) and thickness
   g) Tube length (mm)
   h) Tube surface area inside (m²)
   i) Tube surface area outside (m²)
   j) No. of passes
   k) Water flow (m³/hr)
   l) Water velocity (m/sec)
   m) Water temperature entering (Deg.C)/leaving (Deg.C)
   n) Fin material and No. of fins/inch.
   o) Operating charge
   p) Pressure drop
   q) Refrigerant temp (Deg. C)
   r) Maximum cooling capacity (K.Cal/hr.)
3. **Chiller**

   a) Manufacturer
   b) Shell diameter and length (mm)
   c) Tube material
   d) Fouling factor
   e) No. of tubes
   f) Tube diameter (mm) and thickness
   g) Tube length (mm)
   h) Tube surface area inside (m$^2$)
   i) Tube surface area outside (m$^2$)
   k) Water flow (M$^3$/hr)
   l) Water velocity (m/sec)
   m) Water temperature entering (Deg.C)/leaving (Deg.C)
   n) Fin material and No. of fins/inch.
   o) Pressure drop
   q) Refrigerant temperature inlet /outlet (Deg. C)
   r) Maximum cooling capacity (K.Cal/hr.)
   s) Operating weight (kg)
12.0 **ES8 - CHAIN PULLEY BLOCK**

01 **General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Chain Pulley Block with all accessories complete in all respect. Specific technical requirement of Chain Pulley Block if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Chain Pulley Block is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02 **Description**

Chain pulley block shall be considered conforming to **IS:3832 – 1986**.

**Indian Standard**

Hand-operated chain pulley blocks are used extensively for material handling during construction, erection and maintenance of industrial plants.

The minimum requirements of load chains shall be graded to Grade 40. Further a design test to prove the design of the block to a factor of safety of 4 has been included.

This standard lays down the general requirements and testing of the hand-operated chain pulley blocks, worm or spur gear type.

**Hand-Operated Chain Pulley Blocks** - A block riveted with a load chain and operated by a hand chain so as to give a mechanical advantage.

**DESIGN** - The blocks shall be so designed that all components shall withstand without failure, an application to the block of a load equal to at least four times the working load limit.

**RATING** - The hand-operated chain pulley blocks shall be rated according to the working load limit which in case of a block with four or fewer falls shall be determined from the safe working load of the load chain. Where the falls exceed four, or angles are introduced into the chain run, a chain stronger than that for the corresponding four-fold block is required to provide for the additional load caused by friction.

Each chain pulley block shall be subjected by the manufacturer to a proof load of 1.5 times the working load limit through a length of lift which will ensure that every part of the block will sustain the load test.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer.

1. Make & Model
2. Capacity handling in ton
3. Quantity
4. Class of duty as per IS:3832-1988
5. Head room, mm
6. Lift room, mm
7. Minimum radius of curvature of the track beam with which this hoist can be negotiate
8. Weight
9. Specification of each chain
10. Tools & tackles included in the offer
11. Commissioning spares & 2 years operating spares included in offer.
12. Effort
13. Velocity ratio
01. General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Cooling Tower with all accessories to make operation of Cooling Tower complete in all respect. Specific technical requirement of Cooling Tower if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Cooling Tower is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred for any specific requirement.

02. Description

Cooling tower shall be power driven or natural draft type shall be selected as per job specification requirement.

In General FRP type cooling tower shall be provided for the cooling of condenser recirculating water for HVAC application.

The capacity of the cooling tower shall be adequate to take care of the entire cooling water required for the air-conditioning plant. Only make up water will be made available from the plant network.

The cooling tower shall be mounted on masonry pillars on the floor.

Normally natural draft cooling tower shall have RCC basin construction. Alternatively the party may offer for wooden basin as per job specification requirement. Cooling tower capacity shall be adequate to cool water basin temperature up to maximum 32°C as per prevailing ambient condition.

Cooling Tower

Type : Induced draft counter flow
Casing/ Basin : RCC (for chilled water plant), FRP (for air conditioning systems)
Frame Work : MS hot dip galvanized (for air conditioning systems)
Fills : PVC
Nozzles : Brass
Bolts, nuts, miscellaneous hardware : MS electro galvanized
Fan hub & blades : Cast Aluminium
Fan type : Axial flow, direct drive
Fan speed : 720 rpm
Degree of protection of motor : IP 55 (temperature rise limited to class B)
Ladder : Galvanised steel ladder with safety cage & hand railing up to the top of tower. Inclined to 30° to the vertical
Eliminators : No. of deflector to be arranged to reduce drift loss < 0.2% of water circulation.

Cooling Tower Accessories:
(i) Level switch at cooling tower basin (to be interlocked with pump)
(ii) Make up connection with float valve (float made of copper), back up ball valve
(iii) Quick fill connection with ball valve
(iv) Overflow connection
(v) Drain connection with ball valve
(vi) GI wire mesh 18 gauge strainer
(vii) Equalizing line of cooling towers with isolation valves
(viii) Cooling tower basin (for chilled water plant) shall have minimum 5 minute water holding capacity (of circulation water volume)
DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer for cooling tower.

1. Make & Model
2. Type
3. Quantity
4. Overall size of cooling tower
5. Capacity of cooling in TR.
6. Water flow m³/h
7. Air flow
8. Design water inlet temperature, outlet temperature
9. Material of construction and its thickness
10. Speed in rpm.
11. Drive details.
12. Shaft Power consumption.
13. Wheel diameter.
15. Size of fan
16. Static & Dynamic weight of fan & motor assembly
17. Bare weight and operating weight of cooling tower
18. Noise level at 1m distance in dB(A)
19. Fixing details.
20. Vibration level.
21. Water spray nozzle type
14.0 ES10 - CYCLONES, MULTI-CLONE & PRE-COLLECTOR

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Cyclone / Multi-clone/Pre-collector System with all accessories required to be installed for dust extraction / process application to achieve desired performance in all respect. Specific technical requirement of Cyclone /Multi-clone/Pre-collector System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Cyclone /Multi-clone/Pre-collector is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description

02.1 Single cyclone/group of cyclones

This consists of a vertical cylindrical body, in which dust-laden gas is introduced at the top through horizontal tangential inlet. The cylinder has a truncated cone as the lower section. As the gas moves down the cyclone body, it forms a peripheral vortex. This gives rise to centrifugal force, which throws the dust particles in the gas stream towards the walls which then separate from the gas stream and fall down and are taken out through a dust pipe. As the gas reaches the conical portion, the gas stream reverses direction and moves upwards towards the exhaust pipe forming an inner vortex. Cyclones shall be constructed of suitably stiffened mild steel casing of not less than 6 mm thickness. For variable flow application compartmentalized cyclone chamber shall be constructed to maintain required minimum velocity to achieve desired performance.

02.2 Multi-clone

This shall consist of a number of small diameter cyclones operating in parallel. Multi-cell cyclones shall be enclosed in suitably stiffened mild steel casing of not less than 6 mm thickness. The cyclone elements shall in general have diameters of 150 mm and below and shall have smooth finished surfaces.

Each unit shall include, but not be limited to the following: gas inlet chamber, cyclone elements with casing, clean gas exhaust chamber, bottom hopper for dust collection, rotary valve for each hopper, a differential pressure gauge to measure pressure drop across the unit and leak proof access openings. For variable flow application compartmentalized cyclone chamber shall be constructed to maintain required minimum velocity to achieve desired performance.

02.3 Pre-Collector

The collector shall be used as a preliminary dust catcher and a common header for different incoming ducts from various suction hoods. The collector shall comprise cylindrical casing with service doors of quickly clamped type, incoming and exhaust manifold connected to collector, rotary air lock / double flap valve at the bottom. The dust accumulated at the bottom of collector shall be disposed off through rotary air lock / double flap valve to the conveyor. The velocity of air inside the collector shall be around 4-5 m/s. The Tenderer shall compute the diameter of the collectors to achieve this velocity. The length of the collector shall depend on the convenience of connecting various ducts to it. Duct connections should not be bunched in a particular area and shall be evenly distributed on the cylindrical surface.
of the collector. The mode of connecting incoming ducts with collector body shall be of flanged type. The air shall enter the collector tangentially and not radially. The exhaust duct shall be fitted to the exhaust manifold by flanged connection. The body and support of the collector shall be designed to withstand its self weight along with the weight of water and dust considering worst conditions.

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The tenderer along with the offer shall furnish the following data.

a) Pre-collector

1. Make & Model.
2. Capacity in m$^3$/h.
3. Pressure drop in mmWC.
4. Overall size of pre-collector
5. Velocity through collector body in m/sec.
6. Material of construction
7. Cleaning efficiency Vs particle size
8. Methods of dust disposal.
10. Total weight of pre-collector

b) Cyclone

1. Make & Model.
2. Capacity in m$^3$/h.
3. Pressure drop in mmWC.
4. Overall size of cyclone
5. Velocity through cyclone body in m/sec.
6. Material of construction
7. Cleaning efficiency Vs particle size
8. Methods of dust disposal.
10. Total weight of cyclone

c) Multi-clone

1. Make & Model.
2. Capacity in m$^3$/h.
3. Pressure drop in mmWC.
4. Overall size of multi-clone
5. Smaller cyclone diameter of multi-clone
6. Velocity through multi-clone body in m/sec.
7. Material of construction
8. Cleaning efficiency Vs particle size
10. Supporting frame details.
11. Total weight of multi-clone
15.0 ES11 - DAMPERS FOR AIR FLOW CONTROL

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of air dampers required to be installed in the Air Flow Path with all accessories for HVAC system. Specific technical requirement of air dampers if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of dry air dampers is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Descriptions of the dampers

02.01 Wall mounted dampers

a) Self acting damper (Gravity damper)

Self acting dampers are provided to maintain pressurisation inside the premises. The damper shall be multiblade type made of Aluminium flaps of not less than 24G thickness and MS frame. These shall be designed to operate when the positive pressure inside the premises exceeds 2-3 mm WC. It can operate in fully open or partial open positions.

b) Fusible link fire damper

Fusible link fire dampers are provided to stop the flow of air through the exhaust opening when fire breaks out in the premises. This damper shall be provided at the inside face of wall opening to be provided for outlet/exhaust of air from the premises. This damper shall essentially consist of multi-leaf blades. MS frame, fusible link with spring/gravity arrangement of auto closing of the damper. The fusible link shall be made of low melting alloy which can fuse at a temperature of about 70/80°C. The damper shall be normally in open position; it shall close on melting of the fusible link caused by temperature rise due to fire etc. in the premises.

02.02 Duct line dampers

a) Hand operated damper (Geared hand wheel)

The hand operated damper shall be multileaf opposite acting aerofoil blade type damper with external operating links provided at the outlet of the fan for controlling air flow. The damper shall be made of GI sheet with MS frame unless otherwise specified in the TS. The fully close/ open/ partial closing position shall be marked on the damper casing.

b) Electrically operated/pneumatic damper

The electrically operated damper shall be provided as a regulating device for control of air flow through duct as per TS requirement. Provisions shall be kept for interlocking the damper with fire protection system. The fully closed / open / partial closing position shall be marked on the damper casing.
c) **Solenoid operated fire proof damper**

This damper shall be provided in supply air duct. It shall be operated by solenoid which is to be interlocked with the fire detection system of the served premises. In case of fire in the premises the fire detection system shall activate the solenoid and the solenoid in turn shall close the damper to stop air flow in the duct line. The fully close/open position of the damper shall be marked on damper casing.

### 03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer.

#### 03.01 Wall Mounted Dampers

a) **General data applicable for all types of dampers**

1. Size
2. Quantity offered
3. Material of construction and its thickness
   i) Frame
   ii) Blade
   iii) Flange
4. Provision of horizontal & vertical direction control
5. Weight
6. Velocity of air

b) **Self acting damper**

1. Operate on differential pressure requirement mm WG –

c) **Fusible link fire damper**

1. Material of fuse link
2. Melting temperature of the fuse link

#### 03.02 Duct line Dampers

a) **Hand operated damper (Geared hand wheel)**

1. Operating device

b) **Electrically operated damper**

1. Type of actuator
2. Motor kW /Pole (in case of electrically operated damper)
3. Pneumatic piston (for pneumatic operated damper): make, type and weight
4. Compressed air requirement with pressure for pneumatic operated damper

b) **Solenoid operated fire proof damper**

1. Type of actuator
2. Supply voltage and solenoid power supply rating
16.0 ES12 - DUCTING NETWORK OF DUST EXTRACTION SYSTEM

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Ducting Network with all accessories required to be installed for Dedusting System application to achieve desired performance in all respect. Specific technical requirement of Ducting Network of Dust Extraction System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Ducting Network of Dedusting System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. DUCTING NETWORK

Ducting Network shall comprise of suction hood, ducting, duct support, measuring hatch, cleaning hatch and duct line dampers as required.

Details of collecting enclosure and suction hoods

The suction hoods and enclosures shall be constructed of 5 mm MS plate unless otherwise specified in the job specification with necessary external stiffeners, flanges, counter flanges, fasteners, gaskets and other accessories for fixing with technological equipment and duct line.

Dust collection hoods and enclosures shall be fitted with conveniently placed hinged access doors (top hinged type) to enable internal access to the equipment for maintenance as required. The air velocity at hood inlet shall be 1.5m/Sec (max).

Duct work details shall have following minimum features :

1) Construction

The duct sizing shall be so selected to maintain proper conveying velocity throughout the system. Man holes/hand holes and dust outlets shall be provided at intervals to facilitate cleaning of dusts and for disposal of dust. The successful tenderer shall design the dedusting system ductwork connecting the dust collection hoods, to the dust collector, fans and stack. The ducting shall be fabricated from M.S.(IS : 2062- 1999 ) having thickness as follows unless otherwise specified in the job specification :

...
Duct diameter | Straight line duct thickness | Bend Thickness
---|---|---
Upto 500 mm | 3.15 mm | 4 mm
Upto φ 900mm | 4 mm | 6 mm
φ 900mm to φ 1500mm | 6 mm | 8 mm
φ 1500mm to φ 2000 mm | 8 mm | 10 mm
above φ 2000mm | 10 mm | 10 mm

At all duct bends (carrying abrasive dust such as sinter dust etc.) above 900 mm diameter shall have abrasion resistant liners with caster wood / rock basalt/FRP in line with job specification requirement.

For special application corrosion / abrasion resistant duct liner material of construction of FRP / Linear material may be required to be installed in line with job specification requirement.

2) Conveying velocity
A conveying velocity of 18-25 m/Sec shall be maintained at all points in the ductwork between dust collection hood and dust collection plant to ensure flow of air without settling of dust.

3) Provision for Slide Gates/ Dampers
All extraction points shall have slide gates (single leaf inclined plate type) /dampers provisions for flow balancing during commissioning if required. These gates/dampers shall be bolted by the successful tenderer in position after commissioning to prevent inadvertent operation and consequent un-balancing of flow of the dedusting system.

4) Provision of Flow Testing Points
All extraction branch ducts shall have two 50mm diameter capped sockets installed at 90° to one another at least 6D away from flow disturbance (bends, hood inlets) for insertion of pitot tubes for flow measurement and system balancing during commissioning. Test points are to be located in a readily accessible position in the duct. However in any suction hood if flow appears to be on the lower then necessary flow measurement and correcting device shall be made by the successful tenderer to suit site.

5) Straight Duct Runs
Interconnecting duct work shall be circular in cross section. The duct work shall be fabricated from mild steel plate, IS:2062-1999 or be seam welded spiral wound duct work as per job specification requirement.

6) Branches
Branch connections should be oriented to the top or side of the main with no two branches entering at opposite sides.

7) Joints
Matching flanges are to be bolted together with asbestos rope gasket or rubber gaskets. All bolts and gaskets for jointing shall be included in the successful tenderer scope of work. All duct joints are to be air tight to minimise air leakage.

8) Duct Cleanout Doors
Clean-out doors will be provided on horizontal runs, before elbows and junctions. The spacing between cleanout doors should not exceed 6 meters. Clean out doors will be constructed to have a length of 600 mm or the duct diameter which ever is less for ducts upto 1 meter diameter. Larger diameter ducts will have clean out doors sized 600 mm high by 600 mm wide.

9) Duct system hangers and support
The ductwork support spacing and hangers will be designed for the weight of settled dust plus a 25% design margin. Following dust load will be considered for designing duct and duct support and duct stiffeners.

<table>
<thead>
<tr>
<th>Duct dia</th>
<th>% Cross section of duct filled up with dust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 500 mm</td>
<td>35%</td>
</tr>
<tr>
<td>500 mm to 1400 mm</td>
<td>30%</td>
</tr>
<tr>
<td>1400 mm and more</td>
<td>25%</td>
</tr>
</tbody>
</table>

Bulk density of dust will be considered 1.7 t/m$^3$ unless otherwise specified in job specification.

All inside building duct and duct along main structural building will be supported from plant building structure. Duct supporting member's length height section will be decided during detail engineering. To suit site condition supporting members may have to be modified by the successful tenderer without any commercial implication to the purchaser. All outside ducting network shall have independent duct supporting trestles.

10) Ductwork Layout
Ductwork will not interfere with fixed or mobile crane access to the plant. Horizontal run of the ducting will be avoided to prevent settling of dust.

Minimum horizontal clearance from road center line is 5 meters. It is the successful tenderers responsibility to effect the dedusting system ductwork arrangement in accordance with the design requirements set down in the specification and to the satisfaction of the purchaser/consultant.

11) Ductwork integrity
The successful tenderer’s ductwork design must ensure that the ductwork will not collapse at any point, should it be subject to the maximum suction capacity of the fan system. The design will accommodate any variation in ambient temperature.

12) It is the responsibility of the Successful tenderer to size all ductwork in detail as per duct balancing calculation. Duct balancing calculation will be furnished by the successful tenderer for approval of the purchaser. It is the Successful tenderer’s responsibility to
establish routes both inside and outside building. This is to be done in conjunction with and to satisfy the Purchaser.

13) The duct work will be pressure balance type. However, during testing and commissioning if any throttle piece is required for adjustment of flow in any duct branch same will be carried out by the successful tenderer without any commercial implication.

14) Flexible connection at inlet & outlet of fan and in the ducting network will be provided by the successful tenderer as required.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer.

A. Ducting

1. M² of duct work
2. Weight of duct work
3. Weight of supports and flanges
4. Material and thickness of duct work

B. Suction Hood

1. Material of construction
2. Measuring hatch provided or not
3. Capturing velocity
4. Hoods sizes

C. Duct line Damper – Manual / Elec. Operated

1. Make & Model & Type
2. Size of amp.
3. Material of construction and its thickness
4. Total weight
5. Fixing arrangement
6. Any other information
17.0 ES13 - DUCTING NETWORK FOR HVAC SYSTEM

01. General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of GI/MS Ducting Network with all accessories required to be installed for HVAC application to achieve desired performance in all respect. Specific technical requirement of Ducting Network if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Ducting Network is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description of ducting network

The ducting network comprises of ducting work, duct line dampers, down comer & supply air diffuser with volume control damper (for HVAC system only), supply air grill/ adjustable louver grill duct supporting arrangement, flexible connections etc. All GI /Aluminium ducting work for airflow shall conform to IS 655-1963, Reaffirmed – 1999. Galvanised steel sheet conform to IS– 277– 1992, Amendment 2002. As per job specification requirement ventilation duct may be fabricated from steel sheet conforming to IS –2062 –1999, Amendment 2001.

These items are briefly described below:-

a) Ducting work

Ducting work consists of main duct, branch ducts, bends, reducers, joints, access doors etc. Duct work shall be complete with flanges, gaskets, stiffeners, fasteners (nuts, bolts & washers), hangers, etc. as required. Minor modification of ducting network may be required to suit site condition. GI Ducts shall be fabricated at site to match with site condition. Alternatively ventilation duct work may be fabricated with MS sheet in line with job specification requirement.

All ducting work shall be properly reinforced to prevent sagging, buckling or vibration.

GI Ducting shall be provided with joints at 2.5-3m interval conforming to IS: 655-1963 (RA 1999) as and where required. In case of flanged joints, the flanges shall be of angle iron type riveted with GI sheet on duct perimeter. Flange joints should be made air tight with use of felt gaskets.

Duct supports shall be provided to keep the ducting in position in aligned condition.

Measuring hatch for measurement of flow / pressure shall be provided in ducting network at convenient locations.

For proper distribution of air in the premises supply air grills (adjustable louver grills) with volume control dampers shall be provided in the ducting work for ventilation system and supply air diffusers with volume control damper shall be provided in the ducting work for air conditioning system.
Sizing of the duct shall be done for pressure balancing as well as to maintain the air velocities in the ducting work as given below:

<table>
<thead>
<tr>
<th>Description</th>
<th>Air Velocity for Ventilation System</th>
<th>Air velocity for Air conditioning system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main duct</td>
<td>8 – 10 m/sec.</td>
<td>6 – 7 m/sec.</td>
</tr>
<tr>
<td>Branch ducts</td>
<td>6 – 8 m/sec.</td>
<td>4 – 5 m/sec.</td>
</tr>
<tr>
<td>Supply air grills</td>
<td>4 – 6 m/sec.</td>
<td>-</td>
</tr>
<tr>
<td>Branch risers</td>
<td>-</td>
<td>4 – 5 m/sec.</td>
</tr>
<tr>
<td>Supply air diffuser</td>
<td>-</td>
<td>3 – 4 m/sec.</td>
</tr>
</tbody>
</table>

The following accessories may be fitted in the duct line depending upon the job specification requirement:

i) High efficiency filter  
ii) Strip heater for dehumidification purpose  
iii) Pan humidifier for humidification purpose

**Joints**:

In line with IS 655-1963 guide lines the type of transverse joints shall be follows unless otherwise specified in job specification:

Sealing:

All construction joints and duct seams shall be reasonably sealed with bitumastic cold emulsion or equivalent vapour seal.

**Bends**:

The interior of all ducts shall be smooth for free flow of air. The radius to bend shall be not less than 1.5 D. Turning guide vane shall be provided in all large duct bends and bends with radius less than 1.5 D for proper air flow.

**Access door**:

All main ductwork shall be accessible throughout using tight fitted hinged access doors, provided with sponge rubber gaskets. Angle joints shall be provided with felt or rubber gaskets for leak-tightness of the joints.

Access doors/panels are to be provided at following places:

- Near each fire damper
- Near each Reheat coil
- Near high efficiency filter/absolute filter

Any other place if envisaged by the owner about its essentiality during drawing approval or construction period.

In case access doors are to be installed in the insulated ducts, the access door panel should be insulated too with overlapping, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the duct when the plant is in running condition.
b) **Duct line dampers**

Refer equipment specification no. ES-10.

c) **Adjustable louvers grill (Supply air grill) with volume control damper for ventilation system**

1.25mm MS sheet shall be used for the manufacture of grill. All grills shall be true to shape and shall be checked with a level gauge before being secured in position. No distortion or warping is permitted.

All duct mounted grill shall be complete with rubber gaskets and flanged holding frames of suitable design for the intended installation. They shall be mounted on collar extending from the duct. No part of grilles shall project into the main duct. The adjustable louver grill shall be provided with volume control damper as well as double deflection flap/grill for direction control.

d) **Supply air diffuser with volume control damper for AC System only**

Thickness of Grills, Diffuser, Damper shall be as follows:

- (a) Frame 16 gauge
- (b) Louvers 18 gauge

Supply air diffusers shall be circular/rectangular in shape as per detailed engineering requirement. The throat of a diffuser shall be connected with collar piece provided at the duct bottom for holding the diffuser as well as for supply of air. Each diffuser shall be provided with volume control damper. Each diffuser shall comprise of fixed plate, damper blade, damper blade operating knob, spindle, connecting rod etc. The diffuser should flush with the false ceiling. False ceiling shall not bear the load of any diffuser. The load of diffuser shall be borne by the duct and collar. Each diffuser shall be painted with appropriate colour to match with the colour of the false ceiling. Diffuser shall be placed considering light fittings position and false ceiling runner position. Diffusers/grills shall be of extruded aluminum powder coated/Anodized aluminum.

e) **Return air grill**

In general the return air opening shall be provided above false ceiling in the wall between served premises (control room) and A.C. plant room. The return air grill of suitable size shall be provided at the A.C. plant room side face of the said opening for smooth flow of return air. The air supplied in the served premises (control room) shall come/return above false ceiling through the return air slit of 50~100 mm all around false ceiling along the walls of the served premises. From there it shall pass into the A.C. plant room through the return air passage. The return grill shall comprise of horizontal fixed louvers made of 2 mm thick MS sheet, 50x6 thick MS
flat placed vertically at middle of the louvers, 50x50x6 size angle frame all around. Spacing of the fixed louvers in the grill shall be 25 mm.

f) Insulation

Sheet metal duct shall be acoustically and thermally insulated as per requirement. For details of insulation refer respective equipment specification.

g) Flexible connections

Flexible material shall be used for fabrication of flexible connections of at least 100 mm length shall be provided at each connection between duct work and fan units and any other places as asked in the job specification. Flexible connection material shall be selected considering temperature, pressure application of the job specification requirement.

h) Hangers & supports for ducting

All duct work shall be provided with adequate supports as required to ensure rigid support and to prevent vibration.

The fixing and supports interval shall not exceed 3 meters. Hanger rods having U-bend at one end and threading at other end shall be hanged from angle clit to be anchor fastened from. Hanger rod shall be attached to the ceiling by anchor/ expansion bolts. Duct angle supports from brick wall/RCC wall/ structural wall shall be grouted / welded to suite site.
The following data shall be furnished by the tenderer along with the offers.

a) **Ducting**

1. $m^2$ of duct work  
2. Weight of duct work  
3. Weight of support and flanges  
4. Material and thickness of duct work  
5. Duct support type and material  
6. Velocity of air.

b) **Supply Air Grills (Adjustable louver grills) /Diffuser with volume control facility**

1. Size  
2. Quantity offered  
3. Material of construction & thickness  
4. Provision of horizontal & vertical direction control  
5. Weight  
6. Velocity of air  
7. Methods of volume control

e) **Return air grills/intake air louvers**

1. Size  
2. Quantity offered  
3. Material of construction  
4. Weight  
5. Velocity of air
18.0 **ES14 - ELECTROSTATIC PRECIPITATOR**

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Electrostatic Precipitator (ESP) System with all accessories required to be installed dust extraction / process application to achieve desired performance in all respect. Specific technical requirement of Electrostatic Precipitator (ESP) System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Electrostatic Precipitator (ESP) System is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 Description

1. **Electro Static Precipitator and Accessories will include:**

   - Housing assembly of fabricated plate work.
   - Gas distributor plate at inlet and outlet of ESP.
   - Dust hopper assembly of fabricated plate work.
   - Discharge electrodes.
   - Dust collecting electrodes.
   - Rapping units for both discharge, collecting electrodes and gas distributors.
   - ESP supporting structure complete with service platforms and walkways, stairs, hoisting facilities etc.
   - In general Minimum no. of 4 electric field shall be considered unless defined in the TS to achieve required stack emission standard
   - Two nos. rapping system (for collecting electrodes) at the 3rd & 4th field to control puffing dust.
   - Specific collection area shall be considered based on party experience on past project. However required specific collection area shall not be less than minimum as defined in the TS.

2. **Electrics**

   - High voltage power supply package.
   - Power supply to all drives with interlocks and controls.
   - TR controller with feedback control optimization of current voltage from on line continuous stack monitoring instruments.
   - For details refer job specification requirement.
   - Temperature and pressure transmitter, CO gas analyser as required.

**DESCRIPTION OF ESP SYSTEM**

ESP system will comprise of multiple fields, unit/multiple cells Electrostatic Precipitator (ESP) and its accessories such as Dust disposal system, Electrics and control, Instrumentation, interlocks, Supports etc.
Design requirement

1. The Electrostatic Precipitator (ESP) will be in general dry, horizontal flow type. It should be a completely self-supporting unit, ready to be assembled on the foundation.

2. Configuration

The Electrostatic Precipitator will feature one gas pass design with Compensator at inlet & outlet of ESP.

3. Electrostatic Precipitator casing
   a) The precipitator steel casing will be gas tight and of welded construction throughout. Casing plate thickness will be 6 mm minimum unless otherwise specified in job specification.
   b) The precipitator must cope with the fan running at full output and the fan inlet damper shut without suffering structural or mechanical damage. For gas cleaning system, working pressure will be maintained as per system requirement. The normal working pressure of suction and temperature will be considered as specified in job specification.
   c) The precipitator will have access openings ladders, will stairs, platform etc. necessary for inspection, cleaning and maintenance. All equipment and the openings will be made accessible to the maintenance personnel by installation of access ways, ladders, platforms etc.
   d) Sealing of glands, inspection doors, etc. must be such that air is prevented from leaking into the electrostatic precipitator to prevent in filtration of ambient air. The precipitator will be of weatherproof construction.

4. Electrodes
   a) The discharge electrodes will be of rigid ribbon type so that they can withstand efficient rapping and temperature changes.
   b) Collecting electrodes will have a spacing of approximate 400 mm. The collecting plates should be 1.5 mm thick CR sheets to ensure an adequate service life.
   c) Discharge electrodes and collecting plates will be automatically and sequentially rapped with heavy duty tumbling hammer type mechanicalappers.

5. Rapping

The electrode rapping system will be capable of maintaining clean electrodes. The supplied rapping mechanism will feature a microprocessor based adjustable rapping frequency for each field.

6. Insulator housing

Special attention will be given to the support rapping shaft insulators. These will be electrically heated to avoid condensation and will have efficient seals to avoid dust deposits.
7. Safety

The Electrostatic Precipitator will be provided with a key interlocking system for preventing access to high voltage internals of the precipitator until the associated high voltage system is de-energised and grounded. All the access opening will be provided with earthing rods. The earthing strips will be of GI and it will be firmly bolted to the precipitator casing.

8. Hoppers

Each field of the Electrostatic Precipitator will be fitted with a dust hopper. The hopper will be constructed of 8 mm plate unless otherwise specified in TS. The hoppers will have a pyramidal / conical configuration with 65° valley angle minimum.

Inspection doors, poke holes and electric heaters will be provided in the hoppers. Motorised double cone valves will be provided at the hopper discharge. High and intermediate level switches will be installed in each ESP hopper. With the help of intermediate level switch dust in hopper can be discharged into the chain conveyor by double cone valve. High level switch in ESP hopper will be provided for safety interlocks. Stainless steel liner of 1.6 mm thick up to a height of 1.2 m from the bottom flange of ESP hoppers and storage hopper will be provided for smooth flow of dust.

Separate dust-dumping outlets with flange provision, necessary chutes, gates etc. will be provided by Successful Tenderer with each ESP hopper and dust storage hopper for dumping of dust in case of increase in alkali content to prevent recycling of dust under emergency situations as per requirement. Therefore, Truck / dumper entry provision below each ESP hopper will be provided by Successful Tenderer for dust disposal.

9. Insulation

ESP walls, roof panels, and hoppers will be provided with thermal insulation of resin bonded mineral wool of density 100 kg/m3 as per IS 8183-1993 having 50mm thickness for hot gas application. The thermal insulation will be covered with 0.8 mm CGI sheet cladding.

10. Platforms and access ladders

The minimum platform width will always be 1.00 meters. The platforms will be located at the top of hoppers level and at the top of the gas cleaning equipment. Safe guard rails will be provided around all the platforms. Angular rather than round rails members will be used, if possible. Safe and easy access to the platforms will be provided by providing stairways to chain conveyor platform level, ESP chamber access door level, ESP top and transformer house etc. Maintenance platforms all over ESP area, at dust disposal conveyor level will be provided. Access door to ESP chamber will be provided from both side. Access doors to distributor grid will also be provided. Maintenance platforms at access door level all around ESP will be provided. Ladder approach with platform will be provided for hopper level switches, access doors, hopper heater and for any other equipment or access above man height.
Brief specification of material of construction is mentioned below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item</th>
<th>Material</th>
<th>Thickness (minimum)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Collecting Electrodes</td>
<td>IS-513 CR sheet</td>
<td>1.5 mm</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Discharge Electrodes</td>
<td>IS-513 spiral SS coil / rigid member</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>ESP casing</td>
<td>IS-2062-1999 Gr. A</td>
<td>6.0 mm thick</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>G.D. screen</td>
<td>IS-2062-1999 Gr. A</td>
<td>3.15 mm</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Hopper wall</td>
<td>IS-2062-1999 Gr. A</td>
<td>8.0 mm thick</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Pert house roof (insulator chamber)</td>
<td>IS-2062-1999 Gr. A</td>
<td>5.0 mm thick</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Side wall of insulator chamber</td>
<td>IS-2062-1999 Gr. A</td>
<td>3.15 thick</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>ESP inlet and outlet connection piece</td>
<td>IS-2062-1999 Gr. A</td>
<td>8.0 mm</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Access grating, stair trades</td>
<td>IS-2062-1999</td>
<td>45 depth – 6 mm thick, 40 centre to centre</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Insulation or ESP casing (for hot gas application)</td>
<td>Resin bonded mineral wool IS-8183-1993 density 100 kg/m3</td>
<td>50 mm thick with 0.8 mm CGI sheet cladding</td>
<td>Density of wool 100 kg/m3</td>
</tr>
<tr>
<td>13.</td>
<td>Insulation of hopper (for hot gas application)</td>
<td>Resin bonded mineral wool IS-8183-1993 density 100 kg/m3</td>
<td>50 mm thick with 0.8 mm CGI sheet cladding</td>
<td>Density of wool 100 kg/m3</td>
</tr>
</tbody>
</table>

Keeping in view the properties of the dust, the Successful Tenderer will make selection of material and thickness of plates and supporting structure. However, minimum material of construction specification shall be as mentioned above.

11 Air tightness of ESP housing

The construction of the ESP housing and design of dust disposal gates, insulator boxes and discharge electrodes will be such that air infiltration inside ESP housing is negligible to prevent corrosion problem.

**DESIGN CRITERIA**

1. Following technical input parameters will be considered as a general guide line only for designing the ESP cleaning system since the actual gas & dust composition and condition of gases changes based on operation / process condition of technological plant. Based on the job specification data as well as the past experience of successful tenderer and their collaborator on design of ESP for technological process, successful tenderer will demonstrate and establish performance guarantee parameters under varying process parameters.

   i)  Type : cells, fields, dry/wet horizontal/vertical
   ii) Gas handled : Dusty gas from process application
   iii) Design flow : m³/hr (avg.). at operating temp.
iv) Temperature : -- °C Normal -- °C maximum
v) Bulk density of dust : - t/m^3.
vi) Dust content : - gm /Nm^3.
   at ESP inlet
vii) Dust content : - mg /Nm^3.
   at ESP outlet
viii) Gas velocity : - m/sec
   through ESP
ix) ESP duty condition : 24 hrs continuous operation
x) Chemical composition of air(% vol.)
   Oxygen -
   Carbon dioxide -
   Carbon monoxide -
   Nitrogen -
   Sulphur dioxide-
   Moisture-
   Other constituents-

xi) Chemical composition of dust (% weight)
   CaO -
   SiO_2 -
   Fe_2O_3 -
   Fe -
   FeO -
   Al_2O_3 -
   MgO -
   MnO -
   P -
   S -
   C -
   Na_2O & K_2O -
   Other constituents-

xii) Particle size of dust (% distribution);
    < 5micron :
    5-10 micron :
    10-20 micron :
    20-30 micron :
    30-40 micron :
    > 40 micron :

xiii) Expected cleaning efficiency under normal design condition:
      (moisture content -v/v, Temperature : Deg C ,
      Inlet dust content - gm/Nm3, Gas flow volume - m3/hr)

xiv) Basicity Ratio –

xv) Migration velocity – cm/sec

xvi) Permissible noise level - 85 dB (A)

2. Guaranteed Emission value

The efficiency of the ESP will be such that the guaranteed emission of dust from stack will not be more than 50 mg/Nm^3 or as per job specification requirement.

Correction curves for calculating revised efficiency will be applicable for change in following input parameters:
a) Temperature : Design temperature will be considered as defined in the TS.

b) Moisture content : Correction factor will be not be applicable

c) Dust load : Correction factor will be applicable provided dust emission not exceeding 50 mg/ Nm3.

d) Gas flow : Positive factor or negative correction factor will be applicable for decrease or increase in gas flow respectively.

e) Dust composition : No correction factor will be applicable for gas composition and change in said parameters. Successful tenderer will select the ESP which will be suitable for dust generated by the specific process.

3. The Successful Tenderer will adopt the following criteria while designing dust disposal system.

i) Easy maintenance of dust disposal equipment.

ii) Minimisation of outside infiltration to the ESP casing.

iii) Moisture regulation facilities to control dry dust disposal nuisance as well as too much wet dust handling problem.

4. The equipment will be suitable to operate satisfactorily under such variations of load, pressure and climatic conditions as may occur during working.

5. Working parts of all equipment will be suitably located for convenient operation and will allow access to facilitate easy replacement, connecting up, inspection, lubrication, maintenance and repair, without dismantling other equipment/ components/ structures.

6. The Successful Tenderer will do physical model testing for gas flow distribution study inside ESP at a minimum scale of 1:15 for this project at manufacturer’s works for designing and selection of GD screen. Necessary inside model elements of ESP like GD screen, discharge electrodes, collecting electrodes etc. will be fitted with the model as per scale. Purchaser and purchaser’s representative will witness the above testing at manufacturer’s works. The date of witnessing of the test will be informed by the Successful Tenderer during design engineering.

7. Design calculation of ESP main supports, weather enclosure, structures, platform will be based on IS-875-1987 Part-I, II & III and IS-800-1984. Service load of 4KN/sqm and 2 KN/sqm will be considered for maintenance platform and walk ways respectively.

8. Compensator between rotary feeder and the chain conveyors, between two conveyors and between dust moistener and rotary feeder will be provided to facilitate maintenance. Slide gates will be provided before all the double cone dust valves/rotary feeder. For calculation and design of structural members, accidental fill up of dust up to top of ESP hoppers in worst case will be considered by Contractor.

9. To ensure safe and reliable operation of ESP, the Successful Tenderer will provide the following minimum safety measures.
i) Prevention of condensation inside ESP chamber.
ii) Prevention of rapping system from damage.
iii) Prevention of insulator creeping and damage.
iv) Prevention of air leakage and corrosion.
v) Provision of heat expansion accommodation.
vi) Prevention of personal inquiry.
vii) Lighting resistance and grounding
viii) Explosion protection arrangement.
03. **DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item Description</th>
<th>Technical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>ESP design data</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Model No.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Treatment velocity</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Treatment time sec/Treatment length m</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Aspect ratio</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Press, drop mm WC</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Migration velocity cm/sec</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Guaranteed outlet emission at design conditions</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>WI of ESP with dust, ton</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Overall size, Approx. WxLxH m</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Cross sectional Area m2</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Collaborator</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Casing Design condition</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>TR set rating</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>SCA m²/m³/sec.</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Collecting Electrode</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Height m</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Spacing mm</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Area m²</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Rapper type</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>Discharge Electrode</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>ESP – Proper</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Gas distributor</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Insulator heating</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Bearing</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>ESP, inlet and outlet cones</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Whether enclosure sheeting and fixing hardware for TR set</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Monorail with electrical operated trolley and hoist for lifting TR sets</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Insulation of casing and hopper</td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td>ESP Hopper</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Hopper volume each</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Valley Angle in deg.</td>
<td></td>
</tr>
<tr>
<td>F.</td>
<td>TR Rating and Drive Rating in KW</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>TR sets for different fields with quantity</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Rappers :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gas distributor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Electrode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Electrode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hopper heater</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RAL Valve</td>
<td></td>
</tr>
<tr>
<td>G.</td>
<td>Safety Interlock System</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mechanical Key interlock safety system for each access door</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Lightning arestor and grounding</td>
<td></td>
</tr>
</tbody>
</table>
19.0 **ES15 - FILTER DRY TYPE**

01 **General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of different type of dry air filters required to be installed in the Air Flow Path with all accessories for HVAC system to achieve desired efficiency of cleaning. Specific technical requirement of air filter if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of dry air filter is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 **Description of the dry air filters**

Dry panel type air filter shall be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It shall be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It shall be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel shall be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air shall not exceed 1.5 m/sec. The resistance of air filter shall not exceed 10 mm WC when dirty. Efficiency of the normal air filter shall not be less than 90% down to 10 microns unless otherwise specified in the TS. Cleaning efficiency of the high efficiency air filter shall not be less than 99% down to 5 microns unless otherwise specified in the TS. Absolute filter as required shall be considered in line with job specification requirement. The whole filter and frame assembly shall be mounted at the wall / at the inlet of tube axial flow fan/ metallic box as required Panel type air Filters testing shall conform to IS-7613 –1975 (Reaffirmed – 1996)
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The tenderer along with the offer shall furnish the following data.

a) Dry Panel type filter
   1. Make & Model.
   2. Capacity in m$^3$/h.
   3. Pressure drop in mmWC.
      i) When clean
      ii) When dirty
   4. Effective cross sectional free and face area in m$^2$
   5. Velocity through filter free and face area in m/sec.
   7. Cleaning efficiency Vs particle size
   8. Methods of surface regeneration.
  10. Overall dimensions & no. of filters.
  11. Fixing frame details.
  12. Total weight. free and face area
20.0  ES16 – FILTER VISCOUS OIL TYPE : VOID

01  t
21.0  ES17 – THERMAL & ACOUSTIC INSULATION FOR HAVAC (INSULATION FOR COLD APPLICATION)

01  General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Insulation with all accessories for HVAC application. Specific technical requirement of Insulation if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Insulation is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02.  Description of Insulation requirement:

The insulation of water piping, air-handling units, ducting, chillers etc. shall be carried out as per following specifications (a) to maintain proper temperature of fluid/vapour in the conduits (b) to prevent surface condensation on cold surfaces.

1.  Insulation Materials :

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Surface Material</th>
<th>Insulation material</th>
<th>Insulation</th>
<th>Thickness (mm)</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Refrigerant piping</td>
<td>Closed cell foamed plastic</td>
<td>--</td>
<td>30</td>
<td>Al cladding</td>
</tr>
<tr>
<td>2.</td>
<td>AHU drain pipe</td>
<td>Closed cell foamed plastic</td>
<td>Pipe section</td>
<td>30</td>
<td>Al cladding</td>
</tr>
<tr>
<td>3.</td>
<td>AHU casing and condensate pan</td>
<td>PUF</td>
<td>Slabs</td>
<td>25</td>
<td>--</td>
</tr>
<tr>
<td>4.</td>
<td>Chilled water piping (100 NB &amp; less)</td>
<td>PUF</td>
<td>Pipe section</td>
<td>30</td>
<td>Al cladding</td>
</tr>
<tr>
<td>5.</td>
<td>Chilled water pipe insulation (125 NB &amp; above)</td>
<td>PUF</td>
<td>Pipe section</td>
<td>50</td>
<td>Al cladding</td>
</tr>
<tr>
<td>6.</td>
<td>Cooler</td>
<td>Closed cell foamed plastic</td>
<td>--</td>
<td>50</td>
<td>Al cladding</td>
</tr>
<tr>
<td>7.</td>
<td>Chilled water pumps, valves, flanges etc.</td>
<td>Resin bonded glass wool</td>
<td>--</td>
<td>--</td>
<td>Al cladding</td>
</tr>
<tr>
<td>8.</td>
<td>Expansion tank</td>
<td>PUF</td>
<td>Slab</td>
<td>50</td>
<td>Sand cement plaster</td>
</tr>
</tbody>
</table>
9. Acoustic insulation

10. Under deck thermal insulation

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin bonded glass wool</td>
<td>25 mm</td>
</tr>
<tr>
<td>PUF</td>
<td>50 mm</td>
</tr>
<tr>
<td>Fiber glass tissue &amp; perforated Al sheet</td>
<td>50 mm</td>
</tr>
</tbody>
</table>

3.0 **Ducting**

The air handling ducts shall be insulated with resin bonded glass/mineral wool with density not below 24/48 Kg/M3 with polythene back bessian on outer side. Duct insulation thickness shall be as follows:

- AC Duct in conditioned space: 25 mm thickness
- AC Duct in unconditioned space: 50 mm thickness
- AC Duct with treated fresh air: 50 mm thickness

5.1 **Application Procedure**

Clean the surface with wire brush to make it free from rust etc. Apply two coats of hot bitumen 85/25 to the surface at a ratio of 1.0 Kg/M2 for first coat & in patches for second coat wrap the duct with insulation blankets of the specified thickness. Apply PBH layer on the outside and reinforce it by tying GI wire of 0.5 mm at interval of 450 mm.

Duct in outdoor areas exposed to weather shall be covered with 24 SWG Aluminum sheet bent true to shape and secured with self-tapping screws and over lapped joints sealed with Loidseal – 94.

4.0 **Acoustic Lining**

The first 4.5 meter length of duct starting from each fan outlet shall be provided with insulation for acoustic purposes. The insulation material already specified in clause 2.2.2. Then it shall be covered 0.56 mm perforated Aluminium sheets.

4.1 **Application Procedure**

The duct surface shall first be cleaned from inside. The insulation boards shall be wrapped in Glass Cloth of 7 mil thick. With ends stitched. The boards shall be fixed inside the duct. The insulation shall then be covered with 0.56 (24 SWG) perforated Aluminum sheets.

The sheet and the insulation, shall be secured to the duct by means of cadmium plated bolts, nuts and washers and the ends should be completely sealed off so that no insulation material is exposed.

5.0 **Walls and Ceiling – Acoustic Treatments of equipment rooms**

Insulation material shall be resin bonded glass wool/mineral wool of density 32/48 Kg/M3 of 50 mm thickness.

5.1 **Application Procedure**

Fix 40 mm x 50 mm Deodar/Kail wood battens at 500 mm intervals longitudinally. Then fix cross battens at 1.0 meter C – C using suitable gutties and brass/SS Screws.
Fill each rectangle with 50 mm resin bonded glass/mineral wool wrapped in glass cloth. Then tie with 24 SWG GI wires at 300 mm intervals. Then cover with 24 SWG (0.56 mm) perforated Aluminum sheet having 3 mm perforations at 6 mm C – C. Overlap all the joints and provide beady of 25 mm by 1.5 mm MS flat.

**Extent of Acoustic Treatment:**

- **Walls**: Two of the walls enclosing the room starting from 1 ft. above the floor up to the ceiling.
- **Ceiling**: The entire ceiling covering the room.

**6.0 Measurement**:

The measurement of insulation of vessels, piping and ducts shall be made over the insulated surface area as per IS : 7240 – 1981.

**03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER FOR INSULATION OF HVAC APPLICATION**

The following data shall be furnished by the tenderer along with the offer.

- 22. Make & Type
- 23. Quantity
- 24. Density in kg/m3
- 25. Thermal conductivity
- 26. Sound absorption co-efficient
- 27. Material of construction and its thickness
- 29. Vapour barrier material
- 30. Firel resistance property
- 31. Cladding material
22.0 **ES18 - INSULATION FOR HOT APPLICATION**

01 **General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Insulation with all accessories for hot surface application. Specific technical requirement of Insulation if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Insulation is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02. **Description of Insulation requirement:**

02.1 **General Requirements:**

Thermal insulation shall be provided for all vessels, equipment, pipe fittings, heat exchangers etc. containing fluid or vapour for which it is necessary to (a) Conserve heat (b) Maintain temperature for process control (c) provide for personnel protection.

Thermal insulation system shall be selected so as not to result in a residual heat loss exceeding 150 Watts/M2 under plant operating conditions measured over insulated surfaces. For design, the following data are specified:

- Ambient air temperature : 45°C (Max.)
- Wind velocity : 1 m/sec.
- Surface temperature : Not to exceed 15°C above ambient

Design should include de-rating factors of direct conduction paths e.g. spacer rings and stitching wires normally associated with blanket type insulation material.

02.2 **Reference Standards:**

- IS : 9842  - Specification for pre-formed Fibrous Pipe Insulation, Group– III
- IS : 737  - Wrought Aluminum and Aluminum Alloys, sheets & strips
- IS : 7413  - Code of practice for the application & Finishing of thermal insulation materials at temperatures between 40°C and 700°C (latest revision)

02.3 **Application procedure : Piping:**

- For surface preparation wire brush shall be used to remove rust, dust or oil etc. thoroughly.

- Fix the pre-formed pipe-section insulation of required thickness against each diameter of pipe as per the Thickness requirement for Temperature glass and pipe diameter. Construction (upto 75mm thick – 1 layer thereafter 2 or 3 multi layer) joints should be staggered so that complete breaks are minimum on single layer insulation and no through joints occur in multi layout work. The insulation must be held in position by strapping with 20mm x 24 SWG Aluminium Straps.

- When lightly bonded rock wool mattress are used, they shall be wrapped around the pipes without any under layer. On top of each layer, the wire netting already on top of mattresses should be tightly butted against each other so that the fibers interlock both along the longitudinal
and circumferential joints. The pipe joints shall be stitched with 22 SWG soft GI lacing wire for pipes upto 400mm O.D. For pipes over 400mm O.D., the mattresses should be further secured by strapping with 20 mm x 24 SWG Al. straps at 500mm intervals.

- All uninsulated flanges, pipeline insulation shall be stopped off at a suitable distance from the flange for facilitating withdrawal of bolts without disturbing insulation.

- In regard to supporting of insulation to vertical pipelines it is essential that all the pipe insulation (above 200 NB pipe) should be supported at minimum of 3.0 meters distance by applying insulation support spider clamps. These clamps are fitted around the pipeline bare surface with projecting legs whose length should not be more than 70% of insulation thickness.

**Flanges and Valves**

Removable covers shall be provided over all flanges and valves whenever they are insulated with preformed materials. These covers over valves and flanges shall have provision for quick – release clips.

**Sheet Metal Cladding**

All pipes shall be covered with Aluminum sheet (Aluminum sheet of 24 SWG/0.56mm upto 325mm O.D. inclusive of insulation thickness and Aluminum sheet of 22 SWG/0.71mm beyond 325mm O.D.) conforming to IS:737, to the outside of the insulation with minimum 25mm circumferential and longitudinal over laps. The over lapping should be grooved so as to prevent ingress of water into the insulation. In horizontal piping, joints shall be arranged at an angle of 30 to 40° from the horizontal so as to shed rain water.

When lightly bonded rock wool mattresses have been used as the insulation material, spacer rings shall be required screwing the Aluminum sheet. The sheet metal shall be secured to themselves by self-tapping screws at a pitch not exceeding 150mm.

After securing the Aluminum sheet, the overlapped joints of the sheet metal shall be sealed with metal sealant to make joints perfectly waterproof.

**02.4 Application Procedure – Vessels & Equipment:**

- The surface to be insulated shall be thoroughly cleaned by wire brushing to remove dirt, loose scales, dust etc.

- Where welding is permissible, weld 10 SWG GI spokes at 300 – 400mm diamond pitch.

- ‘L’ shaped lugs to be fixed to the spacer rings made of 25mm x 3mm MS flats at 450mm C – C with 25mm x 25mm x 3mm asbestos mill board washers and 4mm MS rivets.

- The spacer rings shall be fixed around the tank at 900mm C – C by welding ‘L’ shaped lugs to tank body.

- Impale Rock wool lightly bonded machine stitched mattresses with one side wire netting of required density (upto 400° – 100 Kgh/M3, above 400°C – 120 Kg/M3) and thickness with the ends of mattresses butted closely together with lacing wire of 22 SWG. In addition, mattresses shall be secured with tightly tensioned circumferential Aluminium bands at approx. 450mm pitch.
The ends of GI spokes to be bent on the insulation.

The Aluminium metal cladding (22 SWG/0.71mm) is to be fixed on the spacer rings with self-tapping screws at 150mm C – C.

All over lapped joints of Aluminum sheet metal shall be sealed with loidseal-94 to make joints waterproof.

02.5 Expansion Joints:

Expansion joints shall be provided in the insulation to allow for movement and expansion of the pipe or vessel without producing random craAt the expansion joints, there shall be complete cut and the cutout portion shall be 25mm wide and dry filled with loose insulation material the density of which shall be equal to that of the basic insulation. ooking of the insulation. The expansion joints wherever necessary shall be installed by overlapping the cladding material.

<table>
<thead>
<tr>
<th>Pipe temp. °C</th>
<th>Spacing of Expn. Joints in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 200°C</td>
<td>No Expn. Joint.</td>
</tr>
<tr>
<td>201 to 300°C</td>
<td>3.5</td>
</tr>
<tr>
<td>301 to 400°C</td>
<td>3.0</td>
</tr>
<tr>
<td>Above 400°C</td>
<td>2.0</td>
</tr>
</tbody>
</table>

02.6 Design Criteria

<table>
<thead>
<tr>
<th>Ambient air temperature</th>
<th>35°C or 45°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design surface temperature</td>
<td>Not to exceed 15°C above ambient air temperature</td>
</tr>
<tr>
<td>Wind velocity</td>
<td>1 meter/second</td>
</tr>
<tr>
<td>Cladding over insulation</td>
<td>Aluminium (Emissivity : 0.2)</td>
</tr>
<tr>
<td>Insulation material</td>
<td>Rock wool density 144 Kg/M3 upto 350 mm NB, Rock wool mattresses above 350mm NB pipes density 100 Kg/M3 upto 400°C and 150 Kg/M3 above 400°C</td>
</tr>
</tbody>
</table>

General Guidelines for insulation thickness

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>100°C</th>
<th>200°C</th>
<th>300°C</th>
<th>400°C</th>
<th>500°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe NB</td>
<td></td>
<td>Thickness of Insulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>25</td>
<td>40</td>
<td>70</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>200</td>
<td>25</td>
<td>45</td>
<td>80</td>
<td>115</td>
<td>160</td>
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<td>300</td>
<td>25</td>
<td>45</td>
<td>85</td>
<td>125</td>
<td>170</td>
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<td>400</td>
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<td>95</td>
<td>145</td>
<td>190</td>
</tr>
<tr>
<td>500</td>
<td>25</td>
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<td>95</td>
<td>150</td>
<td>195</td>
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<tr>
<td>600</td>
<td>25</td>
<td>55</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Flat</td>
<td>25</td>
<td>60</td>
<td>115</td>
<td>140</td>
<td>255</td>
</tr>
</tbody>
</table>

Note: For piping upto 325 mm OD (including insulation thickness) aluminum sheet thickness – 24 SWG (0.56mm) and beyond 325 mm OD (including insulation thickness) aluminum sheet thickness – 22 SWG (0.71mm).
03. DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER FOR INSULATION OF HOT SURFACE APPLICATION

The following data shall be furnished by the tenderer along with the offer.

32. Make & Type
33. Quantity
34. Density in kg/m³
35. Thermal conductivity
36. Material of construction and its thickness
38. Vapour barrier material
39. Fire resistance property
40. Cladding material
23.0 **ES19- PACKAGE AIR CONDITIONER**

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Package Air Conditioner with all accessories to make operation of Package Air Conditioner complete in all respect. Specific technical requirement of Package Air Conditioner if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Package Air Conditioner is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

02 Description

The water/air cooled packaged air-conditioner will be designed for continuous duty.

The equipment shall be designed, manufactured and tested as per IS:8148-1976 (RA 1995).

The packaged unit shall comprise compressor, cooling coil, refrigerant circuit, fan, air filters, electric drives and controls, instruments and other necessary standard accessories assembled in packaged form in a steel cabinet.

All electrical connections shall be built in, Purchaser will provide the power supply load.

Each package air-conditioner will essentially comprise of compressor, cooling coil, refrigerant circuit, condenser, blowers, air filter, electric drives, instruments and controls and other standard accessories assembled in steel cabinet.

The compressor will be semi-hermetically/ hermetically sealed, mounted on anti-vibration pads & dynamically balanced.

The condenser will be water cooled, shell and tube type with effective surface area for heat transfer taking into consideration the scale factor for water side and optimum number of passes to achieve desired duty conditions water cooled package AC unit. Provision will be made in the steel cabinet for tube side cleaning during maintenance. The condenser will also serve as refrigerant receiver of refrigerant circuit with fusible relief plug. Alternatively as per job specification requirement condenser may be air cooled with fins and tube type with effective heat transfer area taking into consideration high ambient temperature of site selected. A refrigerant receiver shall be provided in the refrigerant circuit. Air cooled condenser along with the fan shall be installed in the free area for movement of outside air through condenser tube for effective cooling of refrigerant.

Cooling coil will be direct expansion type with integrally finned copper tubes and fitted with equalising distributors to ensure equal amount of refrigerant in each circuit. Condensate drip pan will be provided below the cooling coil for collecting the condensate.

The refrigerant circuit will be completely piped at factory and charged with required amount of refrigerant. The circuit will comprise of thermostatic expansion valve, distributor, liquid strainer, liquid line shut off valve, dehydrator etc. The circuit will be protected with safety devices such as high and low pressure cutouts, fusible plug, water flow/differential pressure switch, oil safety switch, time delay relay etc. to protect the unit from damage due to sudden and serious
fluctuations in operating conditions. The refrigerant will be R22 / ANY OTHER OZONE FRIENDLY REFRIGERANT.

For control of temperature and dehumidification of the conditioned premises, thermostat and humidistat will be provided in the package A.C. plant room as per job specification requirement.

The centrifugal blower will be designed for distribution of the conditioned air through the network of duct and supply air diffusers. The impeller will be of forward curved, dynamically balanced for low noise and vibration free operation. The fan will be coupled with motor by V-belt and mounted on anti vibration mounting.

Control & Instruments:

The necessary control and instruments include thermostatic expansion valve, sight glass, strainer, cooling thermostat, heating thermostat, humidistat, strip heater, shut off purge valve and drain valve, dial type pressure and temperature gauges etc. Cooling thermostat and humidistat will be provided in the return air circuit (in A.C. plant room) as per job specification requirement.

The dial type 150mm dia pressure gauge will be provided with isolating cocks/valves. Flow switch will be installed in condenser water inlet line to stop the compressor while water supply stops. High efficiency filter & strip heater will be installed in the supply air duct at the discharge end of packaged unit and the strip heater will be interlocked with the blower of the packaged unit to prevent independent control/switching of heaters as per job specification requirement.

The blower and the evaporative coil sections of the packaged unit will be thermally insulated to minimise thermal leakage. The unit will be supplied with rubber pad for installation on PCC pedestals.

Circulating condenser water cooling pipeline will be provided with strainer and by pass line.

Minimum efficiency of pre filter unit in package AC will be 90% down to 10 micron.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer for Package Air Conditioner Unit.

41. Make & Model
42. Quantity
43. Capacity in TR
44. Overall dimension of Package AC Unit
45. Air flow capacity of blower m3/h
46. Total Pressure, mm WC
47. Fan Motor kW
48. Fan RPM
49. Compressor type, model
50. Compressor motor kW
51. Refrigerant type
52. Condenser type
53. Condenser material of construction
54. Overall size of condenser
55. Material of construction and its thickness of casing
56. Insulating material of casing
57. Total Power consumption.
58. Noise level at 1m distance in dB(A)
59. Vibration isolation pad
60. Performance curve.
61. Fixing details.
62. Refrigerant drier and strainer
24.0 **ES20 - PROPELLER FAN**

**01 General**

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Propeller Fan with all accessories to make operation of Propeller Fan complete in all respect. Specific technical requirement of Propeller Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Propeller Fan is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

**02 Description of Equipment**

Propeller type axial flow fan

This type of fan is used for general air exchange of the premises. The fan shall be heavy duty and wall mounted type propeller fan design shall conform to IS:2312 – 1967 (Reaffirmed 1994). Fan impeller blade shall be of aerofoil section and mounted directly at the motor shaft. The RPM of the fan preferably shall be restricted to 900 RPM. Noise level should not exceed 85 dB(A) at 1 m distance. Air entry shall be from motor side. Louver shutter/non-return damper shall be provided at the outlet side of fan to prevent back draft. The fan shall be provided with fixing frame, supporting lugs and other standard accessories.

**03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER**

The following data shall be furnished by the tenderer along with the offer.

14. Make & Model
15. Capacity in m³/hr
16. Quantity
17. Material of construction
18. Total pressure in kgf/m²
19. Characteristic curve
20. Speed in rpm
21. Size of fan
22. RPM
23. Drive details (kW & power supply)
24. Efficiency
25. Fixing details
26. Weight of fan & motor
27. Performance curve
28. Details of non-return damper/louver shutter
29. Fixing frame
25.0 SCRUBBER (ES21 for DE System Application)

01. General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Centrifugal / Venturi Scrubber System with all accessories required to be installed for dust extraction / process application to achieve desired performance in all respect. Specific technical requirement of Centrifugal / Venturi Scrubber System if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Centrifugal / Venturi Scrubber is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Description

02.1 Centrifugal scrubber

Centrifugal scrubber is essentially a vertical steel cylinder with conical bottom. Casing and bottom are made of heavy gauge sheet steel. The top of the casing is connected to exhaust fan and conical portion of the casing is provided with a hydraulic seal. The rectangular inlet of the scrubber is welded to the casing tangentially with respect to its inside surface and with a slant of 10°C toward casing. Dust deposited on the walls of the inlet duct is washed by water sprayers.

The inside surface of the casing is continuously sprayed by sprayers. The water jet emerges from sprayers in the same direction as the swirling air, and at the same time, tangentially to the inside surface of the casing and thus washes it without producing any droplets. The operation of nozzles is checked through inspection holes located just above them.

Dust laden air enters the bottom cylindrical part of the scrubber casing through inlet duct at an approximate velocity of 20 m/sec. As it enters the scrubber, a portion of the stream is directed upwards along a helical line, following closely the inside surface of the casing and thus washes it without producing any droplets. The remaining stream revolves and descends, rebounds from the scrubber bottom and rises along a helical line but closer to cyclone axis. Both streams merge at the outlet.

A centrifugal force arising on rotation of the air stream ejects dust particles towards the sprayed surface of the scrubber. The majority of the particles reaches the film of water and are captured by it.

Water containing captured dust particles trickles down the casing wall and is removed via the hydraulic seal. The protective baffle provided above the sprayers is intended to minimize entertainment of droplets. The mean air velocity for the full cross section of the cylindrical portion of the scrubber is taken to be 5.5 m/sec.

The efficiency of the scrubber should be sufficiently high so that the dust concentration in the exhaust ducting shall not exceed 50 mg/Nm3.
Venturi scrubber

The venturi scrubber consists of high speed atomizer and centrifugal separator. High speed atomizer consists of converging cone, throat and diverging cone. Air stream is accelerated in converging cone and the velocity of the stream rises. Water is introduced at the throat, where it is atomised due to high pressure.

Dust laden air and water enter the throat, where they are mixed at high energy and extreme turbulence. The throat with its length provides an extended period of thorough mixing. The scrubbed air and entrained droplets (with contaminants entrapped) then enters the diverging cone where further collisions and agglomeration takes place creating larger droplets. The air stream then proceeds to centrifugal separator where liquid droplets due to their coarse size are easily removed from the air stream. The working of the centrifugal separator is similar to that of centrifugal scrubber except that the water sprayers are not required.

The efficiency of the venturi scrubber shall be sufficiently high so that the dust concentration in the chimney does not exceed 50 mg/Nm$^3$ or as per job specification requirement.

DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The tenderer along with the offer shall furnish the following data.

d) Centrifugal Scrubber

11. Make & Model.
12. Capacity in m$^3$/h.
13. Pressure drop in mmWC.
14. Overall size of centrifugal scrubber
15. Air velocity through scrubber body in m/sec.
16. Water quantity and pressure required for scrubbing
17. Spray nozzle quantity, diameter and material of construction
18. Material of construction of scrubber body
19. Cleaning efficiency Vs particle size
20. Water sealing arrangement at bottom of scrubber
22. Supporting frame details.
23. Total weight of pre-collector

e) Venturi Scrubber

1. Make & Model & capacity in m$^3$/h.
2. Pressure drop in mmWC.
3. Overall size of venturi scrubber and centrifugal collector
4. Air velocity at inlet, throat & outlet of scrubber in m/sec.
5. Water quantity and pressure required for scrubbing at throat & slurry disposal at centrifugal collector
6. Spray nozzle quantity, diameter and material of construction
7. Material of construction of scrubber body
8. Material construction of throat
9. Cleaning efficiency Vs particle size
10. Water sealing arrangement at bottom of centrifugal collector
11. Methods of slurry disposal.
12. Supporting frame details.
13. Total weight of pre-collector
26.0 ES22 - STACK

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Stack with all accessories required to be installed for exhaust of air to achieve desired performance in all respect. Specific technical requirement of Stack if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Stack is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02 STACK

1. Construction

Self-supported stack made of M.S. Plates (IS:2062-1999) shall be provided to discharge the cleaned air from each of the system to atmosphere.

The height of the stack shall be as per CPCB norms i.e. 2-3m above the nearest highest building or minimum 30m. Stack shall be fabricated as per IS – 6533-1989 (RA 1995) Part – I & Part –II or as specified in TS.

2. Lightning Protection

Protection against lightning shall be made in accordance with IS:2309-1989 (RA 1995).

Lightning Protection shall be provided by creating a path of minimum electrical impedance from the stack top to an earthing strip on the ground. At about 1500 mm from the stack top, a circumferential conductor (coronal band) shall be provided which is lead-covered, stranded and of tinned copper. This is connected to air-terminal rods (which shall project about 750 mm above the top of the earthing strip. During construction temporary lightning protection shall be provided and this should be in the form of a single conductor connected to a temporary air-terminal at the top of the earthing system on the ground.

Vertical reinforcing bars near the stack base shall be electrically connected to a down conductor. Similarly all steel parts and footing reinforcement should be connected to a down conductor. At the top of the stack the lightning conductors shall be adequately protected from chemical corrosion by applying a lead coating or by other suitable means.

3. Aviation Warning Lights

Aviation warning lights shall be provided even during construction once the stack reaches a height of about 45m above ground. Both temporary as well as permanent provisions shall be of
neon type. These lights shall have sufficient intensity (about 100 lux) so that they are conspicuous considering the background illumination level against which they are viewed.

Day marking shall be provided by painting the stack in contrast colour bands for at least the top one-third of its height. Such bands shall range from 0.75 to 3 m in width with the outer bands in darker colour. The paint used for the bands shall be acid-resistant and shall safely withstand the temperature expected at the top of the stack.

4. **Staircase**

   The stack shall be provided with staircase, landing / resting platform at every 10 m, handrails, painter's trolley, structures etc. Ring platform around stack shall be provided at location of aviation lamps.

5. **Clean-out and Access Door**

   A suitable access door shall be provided at the bottom of the stack.

6. **Sampling Ports**

   The sampling ports shall be provided as per Emission Regulation Part-III or its latest amendments.

7. **Work Platform**

   a) **Construction**
      
      Size and extent of platform: If two ports are required at 90 degrees the work platform should serve that half of the stack circumference between the ports and extend at least 1.2 meters beyond each port. If four ports are required at 90 degrees, the work platform should serve the entire circumference of the stack. The minimum platform width shall always be 1.2 meters regardless of diameter of stack and number of sampling ports.

   b) **Platform Access**
      
      Safe and easy access to the platform shall be provided via stairway or other suitable means.

      Guardrails and Stairwells: A safe guard rail should be provided on the platform. Angular rather than round rails members should be used, if possible. No stairwell or any other opening shall be located within 1 meter of any port.

   c) **Platform loading**
      
      The work platform should be able to support at least three men (average 80 kg each) and 91 kg of test equipment (stack monitoring kit etc.). If the stack exists through a
building roof, the roof may suffice as the work platform, provided the minimum test site conditions are still met.

d) **Clearance Zone**

A three dimensional, obstruction free clearance zone should be provided around each port. The zone should extend 0.6 m above, below, to either side of the port. The zone should extend outward from the exterior wall of the stack to a distance of at least 3 meters.

### 03. **DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER:**

The tenderer along with the offer shall furnish the following data:

**Stack / exhaust dust**

- a) Diameter in mm
- b) Material & thickness
- c) Height in m
- d) Level of sampling port holes
- e) Level of platforms
- f) Support & structure with stairs
- g) Weather Cowl / telescopic duct connection
01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Tube Axial Flow Fan with all accessories to make operation of Tube Axial Flow Fan complete in all respect. Specific technical requirement of Axial Flow Fan if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Tube Axial Flow Fan is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred.

02 Description of Equipment

These fans shall be of heavy duty type and of four kinds, as per service requirement, as follows: a) Roof exhauster, b) Roof mounted supply air fan, c) Wall exhauster, d) wall mounted supply air fan.

Axial fan design shall confirm to IS:3588–1987(Reaffirmed 1994).

The roof exhauster / roof mounted supply air fan shall have multi-bladed impeller with short duct casing while the wall exhauster/ wall mounted supply air fan shall have cone inlet suitable for free discharge of air. The fans shall be capable of withstanding the stresses which may be experienced during normal operation under the condition which it is required for and during over speed test. The noise level shall not exceed 85dB(A) at 1m distance.

The first critical speed of the rotating assembly shall be at least 25% above the operating speed. The speed of the fan shall preferably be limited to 1500RPM for fan with diameter 600mm or less and 960RPM for fans with diameter more than 600mm to limit the noise generation.

Impeller:

The impeller shall be of cast aluminium alloy construction of high efficiency aerofoil section blades. The fan impellers shall be cast in one piece, finished all over and carefully balanced both statically and dynamically as per ISO - 1940. Finally the assembled rotor shall be dynamically balanced.

Casing:

Axial flow fan casings for wall mounted/roof mounted fans and their components shall be suitable for outdoor installation. The casing shall be minimum 2 mm thick. The casings shall be provided with flanges at inlet and outlet. All nuts & bolts associated with it shall be of zinc or cadmium plated. Easily removable inspection cover having galvanised fly nut shall be provided. The covers shall be located such that the grease nipple for all bearings, and also motor terminals are easily accessible through the cover.

Hood and Cowl

a) Roof exhauster/supply air fans shall be provided with hood for protection against
rain and other contingencies. It must ensure no dripping of rain water under any circumstances and will have low pressure drop of air. The hoods shall be provided with a heavy gauge expanded metal bird screen.

b) Rain protection cowls shall be designed to suit wall exhausters for protecting fans from rain. The cowls shall be provided with bird screen of heavy gauge expanded metal netting. The rain protection hood & cowl shall be fabricated from minimum 14G thick MS sheet (Hot dip galvanised).

**Coned Inlet**

Wall exhausters shall be provided with coned inlet made of MS 2 mm thick or 16G, GI sheet.

**Inlet Screen**

Inlet screen shall be manufactured with minimum 14 SWG galvanised wire knitted in 25 mm square mesh. Suitable flanges to protect the edges of the screen shall be provided.

**Fans for Special Application**

These fans & motor when used in explosive / inflammable fume extraction system shall be of spark proof construction. Fan impeller and inside surface of the casing shall be epoxy painted. In case of exposure to acid fumes, the fan along with drive motor, accessories & supports etc. shall have acid proof painting.

**Fan Drive**

All direct drive axial flow fan impellers shall be directly mounted on extended motor shafts special constructional features shall be applicable as for fan. Alternatively as per job specification requirement bifurcated type V-belt drive may be considered.

**Materials of Construction**

The following materials shall be used for the construction of various parts:

a) Impeller : Cast Aluminium Alloy
b) Shaft : EN-8 as per BS-900 or its equivalent
c) Fan Scroll : Heavy gauge M.S.
d) Fan Supports, Frames : M.S. of adequate thickness and Structures
e) Coned inlet for wall Exhausters/supply fans : M.S. 2mm thick
f) Dampers : M.S. of heavy gauge
g) Connection pieces : Galvanised/M.S. unless otherwise specified
h) Bolts and Nuts : Galvanised/M.S. unless otherwise specified
i) Rain protection cowls, hoods and casing for wall & roof exhausters : GI/MS sheet

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer.
63. Make & Model
64. Quantity
65. Capacity in \(\text{m}^3/\text{h}\).
66. Total Pressure, mm WC
67. Material of construction and its thickness
68. Speed in rpm.
69. Drive details like make, kW rating, type, insulation & protection class etc.
70. Shaft Power consumption.
71. Wheel diameter.
72. Efficiency.
73. Size of fan
74. Static & Dynamic weight of fan & motor assembly
75. Critical speed of fan
76. Noise level at 1m distance in dB(A)
77. Performance curve.
78. Air flow direction.
79. Fixing details.
80. Vibration level.
28.0 ES24 – WATER LINE VALVES

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply/fabrication of Valves with all accessories required to be installed for exhaust of air to achieve desired performance in all respect. Specific technical requirement of Valves if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of Valves is given below under clause No. 02. The point wise list of data to be furnished by the tenderer along with the offer is mentioned below under clause No. 03.

02. Valves

Gate valves will be provided at pump outlets & inlets & at tank outlets.

Non return valves shall be provided at pump outlets

Pressure relief valves shall be provided at pump outlet to divert water back to the tank in case downstream usage of water is reduced.

Butterfly valves shall be provided in branch headers to operate a particular group of sprinklers

Globe valves shall be provided on sprinkler headers to control the flow through each sprinkler.

All valves shall conform to the relevant IS code.

Valves

Butterfly Valves shall be provided in water line of size 65 NB and above and ball valve be provided for pipe size below 65 NB

Butterfly valve

Type : Wafer design, flange less
Body : SG iron with nitrile rubber/EPDM lining
Disc : SG Iron with teflon (PTFE) coating
Stem : High tensile stainless steel

The valves shall be provided with integrally moulded & bonded body liner to provide perfect seating and complete isolation of body material from fluid. The body liner shall provide the seating to valve disc, primary seal to the stem & gasket joint with mating pipe flanges. Valves shall be provided with self locking lever operation from open to fully closed position with intermediate positions marked on the indicator plate mounted on the top flange. The valves shall conform to BS : 5155 / IS : 13095. Extended valve
shaft shall be provided so that the lever can be operated without any obstruction on the insulated pipes. Gear operated valves shall be provided for sizes more than 250 NB.

Ball Valve

Body: Cast steel  
Body liner: Nitrile rubber/EPDM  
Ball: ASTM A351 Gr CF8  
3 piece design  
Socket welded type

Ball valves shall be with 200 mm length welded joint pipes from manufacturer works.

Check valve

Type: Dual plate check valve with two springs hinged on a central hinge rod  
Body: SG iron  
Body liner: Nitrile rubber/EPDM  
Disc: ASTM A351 Gr CF8  
Wafer design

03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer.

81. Make & Model -  
82. Type -  
83. Quantity -  
84. Size -  
85. Pressure rating -  
86. Material of construction -  
87. Operating system -  
88. Drive details. -  
89. Gland packing -  
90. End connections -  
91. Service -  
92. Test pressure -
29.0 ES25 - WINDOW TYPE AIR CONDITIONER/SPLIT TYPE AIR CONDITIONER

01 General

This specification outlines the minimum requirement for design, engineering, selection, manufacture, test and supply of Window Type Air Conditioner / Split Type Air Conditioner with all accessories to make operation of Window Type Air Conditioner / Split Type Air Conditioner complete in all respect. Specific technical requirement of Window Type Air Conditioner / Split Type Air Conditioner if any shall be mentioned in the job specification/data sheet as furnished along with the Technical Specification.

Brief description of the Tube Axial Flow Fan is given below under clause No. 02. The equipment-wise list of data to be furnished by the tenderer along with the offer is shown below under clause No. 03.

Job specification of the project shall be referred for any specific requirement.

02 Description

1. Window Type Air Conditioners

Window air conditioners shall comprises of hermetically sealed compressors, air cooled condenser, refrigerant piping, blower, instruments and controls, supply air grill with direction deflector etc. enclosed in a insulated steel cabinet. 3 meter long power cable along with plug and socket unit shall be provided for each air conditioner. Necessary installation fittings like condensate drain pan and fixing attachment shall be provided by the successful tenderer. Any additional services required shall be included in line with job specification requirement. Window air conditioner unit shall conform to IS:1391-1992 Part I.

2. Split Type Air Conditioner

Split air conditioning unit mainly comprises of two section, Indoor and Outdoor section. Indoor section comprises of cooling coil, fan, supply air grill, filter. Outdoor section comprises of air cooled condenser, blower, hermetically sealed compressor. Sealed refrigerant piping inter connect indoor and outdoor section. Outdoor unit shall be installed in open space for easy heat dissipation from condenser. Indoor section shall be ceiling surpended or wall mounted type as per job specification requirement. Duct lines may be connected at the outlet of fan in indoor section with strip heater as per job specification requirement. Remote control unit, thermostat and other standard accessories for successful installation of split type air conditioner shall be included in the scope of successful tenderer. Any additional services required shall be included in line with job specification requirement. Split air conditioner unit shall conform to IS:1391-1992 Part II.
03 DATA TO BE FURNISHED BY THE TENDERER ALONG WITH THE OFFER

The following data shall be furnished by the tenderer along with the offer.

93. Make & Model
94. Quantity
95. Capacity in TR
96. Air Flow m³/h
97. Flow direction and volume control grill
98. Material of construction
99. Compressor type
100. Drive details and total power consumption
101. Overall dimensions
102. Refrigerant type
103. Filter efficiency
104. Weight of unit
105. Noise level at 1m distance in dB(A)
106. Fixing details.
107. Vibration level.
16. Accessories included
30.0 Solid Waste Management System.

Integrated Iron and steel plant generates various type of waste during manufacturing of saleable products. In addition to the main line of production of iron and steel the allied and associated activities give rise to many waste which differ in composition, characteristics as well as physical state.

Solid waste generated in steel plant can be classified in major two groups. One group will be solid waste, which can be recycled/reused in the iron & steel making process in the plant itself and the other groups contain solid wastes which cannot be used in technological process and has to be disposed. Wherever it becomes unavoidable, the wastes shall be disposed under controlled conditions. Disposal of waste shall be done in such a way that the pressure on land and subsequent land contamination shall be progressively brought to minimum.

All efforts shall be made to minimize the generation of waste and maximize the effective utilization of waste in the plant.

All waste from the pollution control system and treatment shall be used or recycled to the extent possible.

Solid waste generated to be managed as per charter of corporate responsibility for Environment Protection (CREP) for Iron and steel Industries published by Central Pollution control Board (CPCB).

As per Minutes of twentieth meeting of the Peer & core expert committee on Developments of Effluent and Emission standards of Iron & steel plants held on Feb 19, 2007, CPCB circulated the following guidelines:

- Total BF slag, BF flue dust utilization shall be 100% by year 2008
- BF gas cleaning plant (GCP) sludge utilization shall be 50% by 2012, New units shall plan to meet the target of 50% utilization from inception stage itself
- Total BOF slag utilization shall be 100% by year 2008
- BOF dust/sludge utilization shall be 50% by 2012, New units shall plan to meet the target of 50% utilization from inception stage itself

Accordingly waste generated in these two plants may be managed.

Hazardous waste generated in the plant shall be handled as per “The hazardous waste (Management and handling) rules 1989 and subsequent amendment”.

Fly ash and Bottom ash generated shall be managed/handled as per latest notification on Ash management by Ministry of environment and forest, Govt of India.

Lead Acid batteries shall be handled and disposed as per Batteries (Management and Handling) Rules 2001.
PAINTING

(CHAPTER-09)
STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT

GENERAL SPECIFICATION
FOR
PAINTING
(GS – 09)

MECON LIMITED
RANCHI - 834002
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01 GENERAL

01.01 This specification covers the materials, tools, facilities and quality requirement for surface preparation and painting of steel structures, equipment, piping, ducts, chutes, wood work etc.

01.02 This is only a general guideline of the painting scheme to be followed by the Tenderer. However, in case a specific painting procedure is stipulated in any tendering specification, then this general guideline shall be superceded. Any special case which may arise from time to time shall be dealt with individually on the merit of each case.

01.03 The term “painting” referred herein covers rust preventive, fungus/insects preventive and decorative coating along with surface protection of the following area but not limited to the areas indicated below.

i) Structural steel works
ii) Mechanical equipment
iii) Electrical equipment
iv) Instrumentation and control equipment.
v) Pipe work
vi) Oxygen plant, etc.

01.04 Surfaces made of asbestos, aluminum, brass, bronze, galvanized steel, stainless steel, cast iron and other corrosion resistant alloys and rubber/synthetic polymer/fiber reinforcement plastic and buried pipe work are not required to be painted unless specified except for aesthetic purposes or for identification bands, wherever relevant.

01.05 The complete paint system for any item includes the following basic activities:

i) Proper surface preparation
ii) Application of primer coats
iii) Application of intermediate coats
iv) Application of finished coats

All the above coats shall be of quality paint products and of approved make. The scope of work shall also include supply of all paint materials as per specification described herein.

01.06 If the contractor desires to adopt alternative paint system for any specific item for an improvement or equivalent to the system specified here-in or as per recommendations of paint manufacturer, may do so subject to purchaser’s approval in advance.

02 SURFACE PREPARATION

02.01 Surface preparation required for paint application, shall be such as to clean the surface thoroughly of any material which will be conducive to premature failure of the paint substrates.
02.02 All surfaces shall be cleaned of loose substances, and foreign materials, such as dirt, rust, scale, oil, grease, welding flux, etc. in order that the prime coat is rigidly anchored to the virgin metal surface. The surface preparation shall confirm to pictorial representation of surface quality grade of Swedish Standards Institution SIS – 055900 or equivalent standards such as SSPC – VIS – 1.67 or DIN 55928(Part 4) or BS 4232 or IS 1477 – 1971 (Part I)

02.03 The acceptable surface preparation quality / grade are described under each paint system. The procedures include solvent cleaning, hand tool cleaning, power tool cleaning, blast cleaning, wood surface cleaning, flame cleaning and pickling. This will ensure surface quality as required by the specific primer paint. For ready reference surface preparation quality grade to be adopted in respect of SIS 055900 and DIN 55928 (part-4) is given in Annexure-01.

02.03.01 **Solvent Cleaning**

The surface shall be cleaned by wiping, immersion, spraying or vapour contacting of a suitable solvent or washing with an emulsion or alkaline solution to remove oil, grease, dirt, old paint, etc. Solvent cleaning shall not remove rust, scales, mill scales or weld flux. Therefore, before application of paint, solvent cleaning shall be followed by other cleaning procedures as stated in subsequent clauses.

02.03.02 **Hand Tool Cleaning**

The surface shall be cleaned manually by vigorous wire brushing as per grade St-2 quality of Swedish Standard Institution SIS 055900 and DIN 555928. This method effectively removes loosely adherent materials, but would not affect residues of rust or mill scales that are intact and firmly adherent. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation the surface shall have a faint metallic shine. The appearance shall correspond to the prints designated St – 2.

02.03.03 **Power Tool Cleaning**

The surface shall be cleaned by electric or pneumatic tools, such as brushes, sanding machines, disc abrasive grinder, rotary disc scaler etc. to St – 3 quality. The tools shall be used carefully to prevent excessive roughening of surface and formation of ridges and burrs. This method will remove loosely adherent materials but would not affect residues of rust or mill scales that are firmly adherent and intact.

02.03.04 **Blast Cleaning**

The surface shall be cleaned by impingement of abrasive materials, such as graded sand at high velocity created by clean and dry compressed air blast as per the grade according to Swedish Standard Institution SIS 055900. This method will remove loosely adherent materials as well as adherent scales and mill scales. Prior to application of blast, heavy deposit of oil and grease are removed by solvent cleaning excessive
surface scales are removed by hand tools or power tool cleaning. The extent of removal of adherent scales is varied, depending on the application and are defined by the surface quality grades Sa1, Sa2, Sa2.5 and Sa3 in the order of increasing cleanliness. The blast cleaning is not recommended for sheet metal work.

02.03.05 **Flame Cleaning**

The surface is cleaned by rapid heating by means of oxyacetylene flame to loosen the adherent scales, followed immediately by wire brushing. This method will remove loosely adherent materials as well as most of the adherent scales and mill scales. In order to minimize or prevent distortion flame cutting shall not be used on members having thickness of 6 mm and lower.

02.03.06 **Pickling**

In this method the surface is cleaned of mill scales, rust or rust scales by chemical reaction or electrolysis or both.

03. **PAINT APPLICATION**

03.01 **Paints**

03.01.01 Paint shall be applied in accordance with paint manufacturer’s recommendations. The work shall generally follow IS 1477 – 1971 (Part II) for jobs carried out in India and SSPC-PA-1 or DIN 55928 or equivalent for jobs carried out outside India.

03.01.02 General compatibility between primer and finishing paints shall be established by the paint manufacturer supplying the paints.

03.01.03 In the event of conflict between this general procedure on painting and the paint manufacturer’s specification, the same shall be immediately brought to the notice of the Purchaser. Generally in cases of such conflicts, manufacturer’s specifications/recommendations shall prevail.

03.01.04 Before buying the paint in bulk, it is recommended to obtain sample of paint and establish “Control Area of Painting”. On Control Area, surface preparation and painting shall be carried out.

03.01.05 If required, samples of paint shall be tested in laboratories to establish quality of paint with respect to:

(i) Viscosity
(ii) Adhesion/Bond of paint in steel surfaces
(iii) Adhesion/Simulated salt spray test.
(iv) Chemical analysis (percentage of solids by weight)
(v) Normal wear resistance as encountered during handling & erection.
(vi) Resistance against exposure to acid fumes, etc.

03.01.06 Whole quantity of paint for a particular system of paint shall be obtained from the same manufacturer.
03.01.07 The main Contractor shall be responsible for supply of paints and this responsibility shall not be passed on to the sub-contractor.

03.01.08 The painting material as delivered to the Contractor, must be in the manufacturer’s original container bearing thereon manufacturer’s name brand and description. Paint/Painting material in containers without labels or with illegible labels shall be rejected, removed from the area and shall not be used.

03.01.09 Thinners wherever used shall be those recommended by the paint manufacturers and shall be obtained in containers with manufacturer’s name and brand name of thinner legibly printed, failing which the thinner is liable to be rejected and shall not be used.

03.01.10 All paint containers shall be clearly labeled to show the paint identification, date of manufacture, batch number, special instruction, shelf life etc. The container shall be opened only at the time of use.

03.01.11 All paints shall be stored in accordance with the requirements of laid down procedure by the paint manufacturer.

03.01.12 All ingredients in a paint container shall be thoroughly mixed to break-up lumps and disperse pigments before use and during application to maintain homogeneity.

03.01.13 The proposed make, quality and shade of the paint shall have the approval of the client.

03.01.14 The colour code of the finishing paint to be followed shall be intimated to the successful Tenderer after finalisation of order. The undercoat shall have different tint to distinguish the same from the finishing coat.

03.01.15 The Contractor shall furnish paint manufacturer’s test report or technical data sheet pertaining to the paint selected. The data sheet shall indicate among other things the relevant standards, if any, composition in weight percent of pigments, vehicles, additives, drying time, viscosity, spreading rate, flash point, method of application, quality of surface preparation required, corrosion resistance properties and colour shades available.

03.01.16 For details of paint materials refer Annexure - 02

03.02 General

03.02.01 Each coat of paint shall be continuous, free of pores and of even film thickness without thin spots.

03.02.02 Each coat of paint shall be sufficiently dry before application of next coat.

03.02.03 Paint shall be applied at manufacturer’s recommended rates. The number of coats shall be such that the minimum dry film thickness specified is achieved. The dry film thickness of painted surfaces shall be checked with ELCOMETER of measuring gauges to ensure application of specified DFT.
03.02.04 Zinc rich primer paints which have been exposed several months before finishing coat is applied shall be washed down thoroughly to remove soluble zinc salt deposits.

03.02.05 The machine finished surfaces shall be coated with white lead and tallow before shipment or before being put out into the open air.

03.02.06 Areas which become inaccessible after assemble shall be painted before assembly (after obtaining painting clearance from the inspecting authority) after requisite surface cleaning as specified.

03.02.07 Paint shall not be applied when the ambient temperature is 5 deg C and below or 45 deg C and above. Also paint shall not be applied in rain, wind, fog or at relative humidity of 80 % and above unless the manufacturer’s recommendations permit. Applications of paint shall be only be spraying or brushing as per IS 486 – 1983 and IS 487 – 1985.

03.02.08 Primer paint shall be applied not later than 2 – 3 hours after preparation of surface, unless specified otherwise.

03.02.09 Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

03.02.10 Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS 958 – 1975 or solvent deposited compound according to IS 1153 – 1975 or IS 1674 – 1960.

03.02.11 Surfaces in contact during shop assembly shall not be painted. Surfaces which will be inaccessible after assembly shall receive minimum two coats of specified primer.

03.02.12 Surfaces to be in contact with wood, brick or other masonry shall be given one shop-coat of the specified primer.

03.03 Site/Field Painting

03.03.01 Wherever shop primer painting is scratched, abraded or damaged, the surface shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

03.03.02 If more than 50% of the painted surface of an item requires repair, the entire item shall be mechanically cleaned and new primer coats shall be applied followed by intermediate and finishing coats as per painting specification.

03.03.03 All field welded areas on shop painted items shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer paint is burnt).
Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

03.03.04 The first coat of finish paint at site shall be applied preferable within three months of the shop paint.

03.04 **Structural**

03.04.01 All fabricated steel structure, fabricated steel pipes, etc. shall have a minimum of two coats of primer paint before dispatch to site.

03.04.02 Parts of steel structures embedded in concrete shall be given a protective coat of Portland cement slurry immediately after fabrication and after surfaces of this part is thoroughly cleaned from grease, rust, mill scales, etc. No paint shall be applied on this part.

03.04.03 All structures shall receive appropriate number of primer and finishing coats in order to achieve overall DFT as per design drawings/specification.

03.05 **Hot Surfaces**

03.05.01 Total DFT for heat resistant paints should not exceed 100 – 120 microns, otherwise flaking occurs (as per paint manufacturer’s recommendations).

03.05.02 Heat resistant paints should be applied by brush.

03.05.03 Primer coat should not be applied on the surfaces having temperature condition more that 120 deg C.

04 **PAINTING SCHEMES**

For a complete painting scheme of any item being printed, all types of paints are to be procured from the same manufacturer as approved by the purchaser.

04.01 **Legend**

- **SP** - Surface preparation quality as per SIS standard
- **2P1** - Two (2) coats of Primer paint type P1
- **1I1** - One (1) coats of Intermediate paint type I1
- **2F1** - Two (2) coats of Finish paint type F1
- **DFT** - Dry Film Thickness in microns developed
- **CRT** - Clean and Retouch

Type of paint products like P1 to P9, I1 to I4 and F1 to F10 have been specified under Annexure-02.

04.02 The painting scheme to be followed for various structure/equipment exposed to different condition is briefly given in Annexure-03 for guidance to the tenderer.
04.03 The colour code for different applications are indicated in Annexure-04. Wherever colour codes are not specified, the same is to be mutually agreed between the Purchaser and Contractor.

05. GUARANTEE

05.01 The Contractor shall guarantee that the physical and chemical properties of the paint materials conform with the specification of paint products.

05.02 The Contractor shall submit internal test reports from paint manufacturers regarding the quality of paint whenever asked by the Purchaser/Consultant.

05.03 Guarantee period shall commence from the date of completion of finishing coat of paint. The guarantee period will be indicated depending on the type of surface preparation and system of painting. To fulfill this obligations the Contractor may obtain from the painting manufacturer, guarantee for the performance of paint/painted surfaces.
### Surface Preparation Grade

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Surface Preparation</th>
<th>Swedish Std SIS 055900</th>
<th>DIN Std. Din 55928 (Part 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blast cleaning to white metal&lt;br&gt;Removal of all visible rusts, mill-scales, paint and foreign matters.</td>
<td>Sa 3</td>
<td>Sa 3</td>
</tr>
<tr>
<td>2</td>
<td>Blast cleaning to near white metal:&lt;br&gt;95% of any section of surface area is free from all rusts, mill-scales and visible residues.</td>
<td>Sa 2.5</td>
<td>Sa 2.5</td>
</tr>
<tr>
<td>3</td>
<td>Blast cleaning to commercial quality:&lt;br&gt;At least 2/3 of any section of the surface area is free from all rusts, mill-scales and visible residues.</td>
<td>Sa 2</td>
<td>Sa 2</td>
</tr>
<tr>
<td>4</td>
<td>Brush-off blast cleaning:&lt;br&gt;Removal of all loose mill-scales, rust and foreign matters etc.</td>
<td>Sa 1</td>
<td>Sa 1</td>
</tr>
<tr>
<td>5</td>
<td>Power tool cleaning:&lt;br&gt;Very thorough scrapping and wire brushing to remove loose mill-scale, rust and foreign matters to have pronounced metallic shine.</td>
<td>St 3</td>
<td>St 3</td>
</tr>
<tr>
<td>6</td>
<td>Hand tool cleaning:&lt;br&gt;Removal by hand brushing of loose mill-scale, loose rust and foreign matters.</td>
<td>St 2</td>
<td>St 2</td>
</tr>
</tbody>
</table>
PAINT MATERIALS

01. PRIMER PAINTS (P)

Primer paint products shall be applied only on dry and clean surfaces.

01.01 Primer Paint – P1 (Phenolic – Alkyd Based)

A single pack air drying phenolic modified alkyd composition with zinc phosphate as a primer paint conforming generally to IS : 2074.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air drying time</td>
<td>About 60 minutes (touch dry)</td>
</tr>
<tr>
<td></td>
<td>Overnight (hard dry)</td>
</tr>
<tr>
<td>Dry film thickness (DFT)/Coat</td>
<td>40 microns (min)</td>
</tr>
<tr>
<td>Temperature resistance</td>
<td>Upto 100°C dry heat</td>
</tr>
</tbody>
</table>

01.02 Primer Paint – P2 (Chlororubber Based)

A single pack air drying high build chlorinated rubber based zinc phosphate primer.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent chlororubber</td>
<td>20 to 22 (% Chlorine above 65% in chlororubber)</td>
</tr>
<tr>
<td>Air drying time</td>
<td>About 15 minutes (touch dry)</td>
</tr>
<tr>
<td></td>
<td>Overnight (hard dry)</td>
</tr>
<tr>
<td>DFT/Coat</td>
<td>50 microns (min)</td>
</tr>
<tr>
<td>Temperature resistance</td>
<td>Up to 65°C dry heat</td>
</tr>
</tbody>
</table>

01.03 Primer Paint – P3 (PVC Copolymer Alkyd Based)

Polyvinyl chloride (PVC) - Alkyd zinc phosphate – redoxide based primer

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>PVC copolymer + alkyd resin (1:1)</td>
</tr>
<tr>
<td>Pigments</td>
<td>Zinc phosphate &amp; Fillers</td>
</tr>
<tr>
<td>Air drying time</td>
<td>24 hours</td>
</tr>
<tr>
<td>DFT/Coat</td>
<td>80 microns</td>
</tr>
<tr>
<td>Temperature resistance</td>
<td>Upto 80°C dry heat</td>
</tr>
</tbody>
</table>
01.04 **Primer Paint – P4 (Epoxy Based)**

A two pack air drying Epoxy polyamide resin based red oxide-zinc phosphate primer.

- Epoxy content (% wt.) - 15 to 18
- Air drying time - 
  - About 30 minutes (touch dry)
  - Overnight (hard dry)
- DFT/Coat - 30 microns (min)
- Temperature resistance - Upto 120°C dry heat

01.05 **Primer Paint – P5 (Epoxy Based)**

A two pack air drying Epoxy polyamide with zinc dust of at least 92% zinc dust on the dry film.

- Epoxy content (% wt.) - 8 to 10
- Air drying time - 
  - Less than 10 minutes (touch dry)
  - Less than 2 hours (hard dry)
- DFT/Coat - 40 microns (min)
- Temperature resistance - Upto 300°C dry heat

01.06 **Primer Paint – P6 (Poly – Vinyl Butyral Resin Based)**

A two pack air drying polyvinyl butyral resin based wash primer with rust inhibitive pigments.

- Air drying time - 
  - 5 to 7 minutes (touch dry)
  - 2 hours (hard dry)
- DFT/Coat - 8 microns
- Temperature resistance - Upto 65°C dry heat
- Application for - Galvanised iron, aluminium, light alloys etc. on which the adhesion of conventional paints are poor.

01.07 **Primer Paint – P7 (Ethyl Zinc Silicate, EZS Based)**

A two pack heavy duty zinc dust rich silicate primer which protects the surface with just a single coat.

- Total solids (3 wt) - 84 +/- 2
- Density (g/cc) - 3.07 +/- 0.05
Air drying time - To top coat 16 hours
DFT / coat - 60 microns
Temperature resistance - Upto 450 deg C dry heat

**01.08 Primer Paint – P8 (High Build Coal Tar Epoxy)**

A two pack cold cured H.B. epoxy coal tar coating – no primer is required.

Mixing ratio - Base: Hardener (4:1 by vol.)
Air drying time - 48 hours (hard dry)
DFT / Coat - 100 microns

**01.09 Wood Varnish-P9**

Treated oil based primer pigmented with suitable pigments:

Air drying time - 16 hours for application of top coat.
Coverage - 10 to 14 sq. m/litre

**02. INTERMEDIATE PAINTS (I)**

These paints shall be applied over primer coats as an intermediate layer to provide weather proof seal of primer coats.

**02.01 Intermediate Paint-II (Phenolic alkyd based)**

A single pack high build phenolic based paint with micaceous iron oxide (M10).

Air Drying Time - 4 to 6 hours (touch dry) - 2 days (hard dry)
DFT /Coat - 75 microns (min)
Temperature resistance - Upto 100 deg C dry heat
Compatible with - Primer P1

**02.02 Intermediate Paint-I2 (Chlororubber based)**

A single pack air drying high build chloro based paint with MIO.

Air Drying Time - 15 minutes (touch dry) - 24 hours (hard dry)
DFT /Coat - 70 microns (min)
Temperature resistance - Upto 65 deg C dry heat
Compatible with - Primer P2, P3 & P4

**02.03 Intermediate Paint-I3 (PVC – Alkyd Based)**

PVC Coploymer - Resin 1:1
Pigments - Micaceous iron oxide (MIO)
DFT /Coat - 80 microns (min)
Temperature resistance - Upto 80 deg C dry heat
Compatible with - Primer P2 & P3

02.04 **Intermediate paint-I4**

A two pack air drying high build epoxy resin based paint with MIO.

Air drying time - 6 to 8 hours (touch dry)
- 7 days (full cure)
DFT / coat - 100 microns
Temperature resistance - Up to 180\(^\circ\)C dry heat
Compatible with - Primer P4 & P5

03. **FINISH PAINTS (F)**

Finish paint costs shall be applied over primer coats and intermediate coats after proper cleaning and touch up of primed surface.

03.01 **Finish Paint – F1**

A single pack air drying high gloss phenolic alkyd modified synthetic enamel paint suitably pigmented.

Air drying time - 3 to 4 hours (touch dry)
- 24 hours (hard dry)
DFT/Coat - 25 microns (min)
Temperature resistance - Upto 100\(^\circ\)C dry heat
Compatible with - Primer P1
Intermediate I1
Colour - Generally all shades

03.02 **Finish Paint – F2**

A single pack air drying polyurethane enamel of high gloss and hard finish suitably pigmented.

Air drying time - 2 to 2 ½ hours (touch dry)
- 6 hours (hard dry)
DFT/Coat - 30 microns (min)
Temperature resistance - Upto 100\(^\circ\)C dry heat
Compatible with - Primer P1 & P8 and Intermediate I1
Colour - Generally all shades
03.03 **Finish Paint – F3**

A two pack air drying bituminous aluminum paint.

- Air drying time:
  - 1 to 2 hours (touch dry)
  - 21 hours (hard dry)
- DFT/Coat: 25 microns (min)
- Temperature resistance: Upto 100°C dry heat
- Compatible with: Primer P1 and Intermediate I1
- Colour: Bright metallic

03.04 **Finish Paint – F4**

A ready mixed oil-alkyd based synthetic enamel paint of high gloss and hard wearing properties.

- Air drying time: 6 to 8 hours
- Coverage: 14 to 16 Sq. m /litre
- Temperature resistance: Upto 60°C dry heat
- Compatible with: P8
- Colour: Generally all shades

03.05 **Finish Paint – F5**

A single pack air drying plasticized chlororubber paint suitably pigmented.

- Air drying time:
  - 30 minutes (touch dry)
  - 24 hours (hard dry)
- DFT/Coat: 35 microns (min)
- Temperature resistance: Upto 65°C dry heat
- Compatible with: Primer P2 & P3, Intermediate I2 & I3
- Colour: Nearly all shades except few.
03.06 **Finish Paint – F6**

A PVC – Copolymer alkyd based enamel.

Density - 1.17 ± 0.05

Total solids (1 wt) - 55 ± 2

DFT/Coat - 40 microns

Compatible with - P2 and P3

03.07 **Finish Paint – F7**

A two pack air drying epoxy polyamide enamel suitably pigmented.

Air drying time - 2 to 3 hours (touch dry)
- 7 days (full cure)

DFT/Coat - 40 microns (min)

Temperature resistance - Up to 130°C dry heat

Compatible with - Primer P4 & P5, Intermediate I4

Colour - Generally all shades.

03.08 **Finish Paint – F8**

A single pack synthetic rubber based aluminium paint.

Air drying time - 2 hours (touch dry)
- 24 hours (hard dry)

DFT/Coat - 25 microns (min)

Temperature resistance - Upto 200°C dry heat

Compatible with - No Primer paint except primer P6 is applicable in case of non-ferrous substrate.

Colour - Smooth aluminium.
# PAINTING SCHEME

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>1.0</td>
<td>Steel Structures (Temp. not exceeding 80°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Technological steel structures for plant and equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>SP – Sa 2.5</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>SP – Sa 2.5</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td>1.2</td>
<td>Fabricated steel structures at site for rung ladders, cat-ladders, gates, rolling shutters, etc. (Springs/rubbing surfaces excluded)</td>
<td>SP – St-2 and/ or St-3</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td></td>
<td>Indoor / Outdoor</td>
<td>SP – St-2 and/ or St-3</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td>1.3</td>
<td>Walkways, stairs, platforms etc. which are of wearing surface</td>
<td>SP – St-2 and/ or St-3</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>SP – St-2 and/ or St-3</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>SP- St2 and/ or St-3</td>
<td>CRT 2F1</td>
</tr>
<tr>
<td>1.4</td>
<td>Steel doors and windows</td>
<td>SP–St-2 and / or St-3</td>
<td>CRT 2F2</td>
</tr>
<tr>
<td></td>
<td>- Indoor / outdoor</td>
<td>SP–St-2 and / or St-3</td>
<td>CRT 2F2</td>
</tr>
</tbody>
</table>

## 2.0 MECHANICAL EQUIPMENT

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>2.1</td>
<td>Mechanical equipment (Temp. not exceeding 80°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1.1</td>
<td>Static equipment like storage tanks, vessels, bins, bunkers, heat exchangers, coolers,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Painting Scheme

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Rotary/moving equipment and machineries like crushers, mills, vibratory screens, bin activators, blowers, fan, air/gas compressors, pumps, gear boxes, machine housings etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>SP – Sa 2.5</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2P2/2P3</td>
<td>2F5/2F6</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>SP – Sa 2.5</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2P2/2P3+1I2/1I3</td>
<td>2F5/2F6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>3.0</td>
<td>Pipe / Duct work (Overground)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Non – insulated (temperature up to 80°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoor</td>
<td>SP – St2 and or St3</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2P1</td>
<td>2F1</td>
</tr>
<tr>
<td></td>
<td>Outdoor</td>
<td>SP – St2 and / or St3</td>
<td>CRT</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2P1 + 1I1</td>
<td>2F1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>4.0</td>
<td>Oxygen Plant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Outdoor steel structures</td>
<td>SP – St2 and / or St3</td>
<td>CRT</td>
</tr>
</tbody>
</table>
### Paint Scheme

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Painting Scheme</th>
<th>Total DFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Shop</td>
<td>At Site</td>
</tr>
<tr>
<td>4.2</td>
<td>Rotary equipment like air compressors</td>
<td>2F3</td>
<td>2P1 + 1I1</td>
</tr>
<tr>
<td>5.0</td>
<td><strong>Others</strong></td>
<td>CRT</td>
<td>2P4</td>
</tr>
<tr>
<td>5.1</td>
<td>Standard mobile equipment like chasis of trucks, dumpers, crawler cranes</td>
<td>As per manufacturer’s standards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bulldozers, railway rakes, chasis of slag cars, ladle cars, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Laboratory equipment like ovens, screens, magnetic stirrers, samplers, etc.</td>
<td>CRT</td>
<td>Stove enamelling</td>
</tr>
<tr>
<td>5.3</td>
<td>Steel structures partly immersed in water</td>
<td>CRT</td>
<td>SP – Sa 2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2P8</td>
</tr>
</tbody>
</table>

**Notes:**

1. Painting scheme of all fabricated steel structures, fabricated pipe work, building structure, conveyor galleries, pipe trestles etc. is indicated in the Technical Specification of steel structures.

2. **Primer Paint**

   Primer coat shall be suitable for intended temperature applications as per manufacturer’s recommendation. The primer selection shall be generally in line with the specification laid down in Annexure-02.

3. **Finish Paint**

   In case of Aluminium cladding final painting will not be required.
COLOUR CODE

The colour codes are mentioned for all the items including pipe work. Shades of finish coat of paint applied over respective item indicated below are tentative and subject to alteration as per Purchaser’s request or due to compatible paint system adopted. The service for which colour code/bands are not specified are to be mutually agreed for by the Purchaser & the Contractor.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Items Painted</th>
<th>Colour</th>
<th>Colour No. of IS:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Structures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building frames including bracings, side girts, louver etc.</td>
<td>Aircraft grey</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Crane girders</td>
<td>Azure blue</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Crane stops</td>
<td>Post office red</td>
<td>538</td>
</tr>
<tr>
<td></td>
<td>Gutters</td>
<td>Black bituminous aluminium</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Fire escape platforms ladders, etc.</td>
<td>Signal red</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>General hand railing, top runners</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Rung ladders</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>All members blocking passages for movement</td>
<td>Lemon yellow</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Trestles, towers and pipe bridges</td>
<td>Dark admiralty grey</td>
<td>632</td>
</tr>
<tr>
<td></td>
<td>Conveyor gallery structures</td>
<td>Aircraft grey</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Steel chimneys</td>
<td>Aluminium</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td><strong>Equipment and Machinery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General indoor equipment</td>
<td>Light grey</td>
<td>631</td>
</tr>
<tr>
<td></td>
<td>General outdoor equipment</td>
<td>Dark admiralty grey</td>
<td>632</td>
</tr>
</tbody>
</table>
|         | Crane bridges, trolleys, hooks etc. and other mobile equipment | Base: Lemon yellow  
        |                                                  | Stripes: Black (100 mm wide)     | 355                |
|         | Furnaces                                           | Aluminium                        |                    |
|         | Tanks                                               | Base: Same as for general equipment  
        |                                                  | Stripes: Same shade as for piping around the tank at half the tank height | |
|         | Fire-fighting equipment                            | Signal red                       | 537                |
| 3.      | **Pipe work**                                      |                                  |                    |

Colours shall be as given below. The base colour shall be applied throughout entire length except on surfaces of materials such as asbestos, aluminium, brass, bronze, galvanized steel, stainless steel and other corrosion resistant alloys and rubber / synthetic polymers. In such cases identification colour bands of at least 500mm width shall be provided near each branch, valve and at distances not exceeding 10m either as local colour coatings or coloured adhesive type of suitable material or label attached to the pipe work. Additional identification bands superimposed over the base colour shall be provided near each branch, valve and at distance not exceeding 10m. The bands shall be atleast 25mm wide except in case of double bands where the first band shall be about 100mm wide. Direction of flow shall be clearly marked on the pipelines at intervals not exceeding 10m and all branches and change of directions.
<table>
<thead>
<tr>
<th>Service</th>
<th>Colour</th>
<th>Colour No. of IS:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea or river water (untreated)</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band - White</td>
<td>-</td>
</tr>
<tr>
<td>Cooling water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band - White</td>
<td>166</td>
</tr>
<tr>
<td>Boiler feed water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td>Condensate</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Light brown</td>
<td>410</td>
</tr>
<tr>
<td>Drinking water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>First band - French blue</td>
<td>166</td>
</tr>
<tr>
<td></td>
<td>Second band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Industrial water</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Light orange</td>
<td>557</td>
</tr>
<tr>
<td>Compressed air</td>
<td>Base – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td>Instrument air</td>
<td>Base – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>Band – Light brown</td>
<td>410</td>
</tr>
<tr>
<td>Drainage</td>
<td>Base – Black</td>
<td>-</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>Base – Light brown</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td>Band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Coke oven/BF gas/other fuel gases</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Argon</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – French blue</td>
<td>166</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Dark violet</td>
<td>796</td>
</tr>
<tr>
<td>LP Gas (LPG)</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>First band – Signal read</td>
<td>537</td>
</tr>
<tr>
<td></td>
<td>Second band – Traffic green</td>
<td>267</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – Black</td>
<td>-</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Base – Canary yellow</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Band – White</td>
<td>-</td>
</tr>
<tr>
<td>Non-acidic slurries</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – White</td>
<td>-</td>
</tr>
<tr>
<td>Fire-fighting system</td>
<td>Base – Signal red</td>
<td>537</td>
</tr>
<tr>
<td>Rain water down pipes</td>
<td>Base – Sea green</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Band – Sky blue</td>
<td>101</td>
</tr>
<tr>
<td>Duct work</td>
<td>Base – Aluminium</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note**: For these services, hazard marking as per fig. 4C of IS:2379 shall also be provided.
FIRE FIGHTING

(CHapter-10)
GENERAL SPECIFICATION
FOR
FIRE FIGHTING
(GS – 10)
# CONTENTS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>PORTABLE FIRE EXTINGUISHERS</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>PASSIVE FIRE PROTECTION</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>HIGH VELOCITY WATER SPRAY SYSTEM (HVWS) / WATER MIST SYSTEM AND MEDIUM VELOCITY WATER SPRAY SYSTEM (MVWS)</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>CARBON DIOXIDE SYSTEM / CLEAN AGENT SYSTEM AND FOAM SYSTEM</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>HYDRANT SYSTEM</td>
<td>35</td>
</tr>
</tbody>
</table>
A. **GENERAL SPECIFICATIONS FOR PORTABLE FIRE EXTINGUISHERS**

01. **SPECIAL INSTRUCTION TO TENDERER**

01.01 Portable fire extinguishers bearing IS marking shall only be supplied.

01.02 The following information shall be furnished with the tender.

(i) GA and cross-sectional drawings of the equipment covered in the specification.

(ii) Catalogues for the above.

(iii) Name and address of manufacturer for various equipment.

(iv) Test pressure.

(v) Materials of construction of various components.

(vi) Weight of each item/assembly.

(vii) Copies of ISI approval/TAC approval/or other statutory authority certificates & Test Certificates

(viii) Reference list.

(ix) List of 2 years operation and maintenance spares as well as fast wearing item along with unit rates.

(x) Additional 10% portable fire extinguishers at each categories shall be also included in scope of supply for maintenance and replacement purpose.

01.03 Necessary tools, spanners etc. required for regular operation/maintenance of the equipment shall be supplied along with the equipment and shall be mentioned in the offer.

01.04 All equipment shall be so packed to avoid any damage during transit.

01.05 The tenderer shall guarantee satisfactory performance of all the equipment supplied by him.

01.06 No deviations or exceptions from this Specification shall be permitted without the written approval of the Purchaser/consultant. Intended deviations if any, shall be listed by the vendor on a separate sheet of paper at the time of bids submission and
supported by reasons for consideration by the Purchaser / consultant.

01.07 Compliance with this Specification shall not relieve the contractor of his responsibility of furnishing equipment and auxiliaries of proper design, materials and workmanship to meet the specific operating condition

01.08 All the equipment shall be provided with test certificates. A certificate shall be produced from Chief Inspector of Explosives in case of Carbon dioxide extinguishers. IS/TAC approval shall be required for all types of extinguishers.

01.09 All portable extinguishers shall be supplied with mountings, accessories and installed along the column/walls near entry/exits and at height of approximately 1200 mm from the finished floor level. Wherever extinguishers are required to be installed on the steel columns of the building, the welding of the supporting fixture to columns shall be done by the successful tenderer. Necessary welding set for this job shall be arranged by the tenderer. The tenderer shall mark / provide border around the fore extinguisher installing point / fire point describing details as specified by fire officer in florescent paint.

01.10 **Approval of Drawings**

The following drawings and document shall be submitted by the successful tenderer for Purchaser/Consultant’s approval within one month after placement of order :-

(i) GA and cross-sectional drawings showing all dimensions and materials of construction of various components.

(ii) Distribution of extinguishers with respect to their type, capacity and numbers in various premises will be decided in accordance with IS – 2190-1992. A drawing/table showing such distribution shall be submitted for approval.

(iii) Quality Assurance Plan (QAP) in MECON’s format

01.11 **Performance Guarantee and Warranty**

The Equipments supplied shall be guaranteed for satisfactory performance as per General Condition of Contract (GCC).

All equipment supplied shall be subject to WARRANTY for a period of 12 months from the date of commissioning of the plant. The warranty shall cover defect, defect in material or workmanship for sub-assemblies as well as the total assembled equipment Initial fill
of gas and other fire extinguishing media (including quantity required for PG test) shall be under the scope of tenderer and quantity/item used for testing/PG shall be replenished by the tenderer free of cost.

01.12 Scope of Inspection

- Verify and certify the material (equipment) offered meets all the details mentioned in the specifications.

- Welding materials/rods shall be checked for meeting specifications/standards. Wherever radiography welding is required, the same has to be inspected (only for welding applications).

- Extinguisher is as per relevant IS codes mentioned in the specifications.

- Checking performance of extinguisher on random basis.

- Check the fire extinguisher as per the design calculations.

02.00 TECHNICAL SPECIFICATION

02.01 5 Kg & 10 kg DCP Fire Extinguishers:

Portable fire extinguisher dry chemical powder gas cartridge type, 5 kgs. Capacity with initial charge (monex) confirming to IS:2171-1999 and ISI marked. The body is cylindrical in shape fabricated by mild steel sheet of 2 mm thickness treated internally with Lead-Tin alloy applied by hot dipping process to a thickness not less than 0.012 mm as led down in the IS:2171 and externally with epoxy powder anticorrosive coating, fitted with nozzle. Discharge tube with nozzle shall be provided as per the relevant IS. The cartridge is manufactured as per IS:4197:1985 and ISI marked. The material of cap, neck ring are of stainless steel (as per IS:6529) and siphon tube shall be of brass construction. Two nos. of extra gas cartridge and 2 nos. of discharge tube shall be provided with each extinguisher. The extinguishers are painted with fire red colour provided with wall mounting breakers and screws complete.

Specifications:

a) All components, design and performance should be as per IS-2171-1999 and with anti corrosive treatment.

b) Hose shall be of braided plastic (high pressure) having one metre length with nozzle of ABS Plastic.
c) Cap shall be of gunmetal and siphon tube shall be of brass construction suitable to fit extinguisher neck ring of 3” straight pipe thread (SPT) and 11 thread per inch (TPI). Major, minor & pitch dia of the thread 87.887, 84.93 & 86.409 mm respectively.

d) Certification that every extinguisher has undergone radiography, quality welding and fabrication and design of vessel as per IS:2825-1969.

f) In addition to markings stipulated in IS-2171-1999 the following permanent punching at the bottom ring is required.

i) Manufacturer’s name

ii) Year of manufacturing

iii) Manufacturers serial

iv) Purchase order no. and date

v) Inspector’s Stamp

vi) The date of hydraulic test along with be the dates of subsequent hydraulic tests.

vii) Dry Chemical Power filling height should be marked on the extinguisher.

02.02 2.0 Kq & 4.5 Kq CO₂ Fire Extinguisher

CO₂ type (2.0 Kq & 4.5 Kq capacity) fire extinguisher assembled out of cold drawn seamless steel cylinder having CCE Approval and conforming to IS:2878-1986 shall be provided. It shall be complete with ISI marked wheel type valve, one metre hose and discharge horn, complete with fittings. The cylinder shall be fully charged with CO₂ gas. In addition to markings stipulated in IS:2878 (1986) the following permanent punching shall be provided.

- Manufacturer’s name
- Year of manufacturing
- Manufacturers serial number
- Purchase Order No. and date
- Inspector Stamp.
02.03 9 Lit Water Type Fire Extinguisher

Portable fire extinguisher water gas cartridge type 9 ltrs. capacity upright operation with initial charge manufactured as per IS:940 – 2003 and ISI mark. The body is cylindrical in shape fabricated with mild steel sheet of 2 mm thickness and treated internally with Lead-Tin alloy applied by hot dipping process to a thickness not less than 0.12 mm as led down in the IS:940-2003 and externally with epoxy powder anti corrosive coating. A high pressure hose of length 600 mm is to be fitted to the body. The material of neck ring and cap shall be of stainless steel (as per IS:6529) and siphon tube of brass construction. The cartridge is manufactured as per IS:4977-1985 and ISI marked. The extinguisher is painted with fire red colour and provided with wall mounting brackets and screws complete. Extra 2 nos. of 60 gms. CO₂ gas cartridge and 2 nos. of discharge tube shall be provided with each extinguisher.

- Manufacturer’s name
- Year of manufacturing
- Manufacturers serial number
- Purchase Order No. and date
- Inspector Stamp.

02.04 Fire Bucket

Galvanised mild steel fire bucket capacity 10 litres as per IS:2546-1974 shall be provided as Class A fire in various premises. The fire bucket should also bear ISI marking on their body. The requirement with respect to shape, design, material and finish shall be strictly according to this IS. The bucket shall be fabricated of MS black sheets to IS:1079 - 1968 (Grade 57 34 or grade 57 42). After fabrication bucket shall be galvanized. The body shall be in two valves joined together by butt welding. The top rim of body shall be wired and uniformly beaded. Thickness of body shall be 1 mm and dia of beading wire shall be 3.55 mm.

Top and bottom handles shall be provided for easy use of buckets.

For keeping buckets in the premises, metallic stands each accommodating 2-6 buckets as required, shall be provided.

02.05 9 Lit Capacity Mechanical Foam Type (AFFF)

Portable fire extinguisher mechanical foam (Gas cartridge) type of 9 litres capacity with initial charge manufactured as per IS:10204-2001 respectively with ISI mark. The body is cylindrical in shape fabricated by mild steel sheets of 2 mm thickness and treated internally with Led-Tin alloy applied by hot dipping process to a thickness not less than 0.012 mm as led
down in the IS:10204:2001 and externally with anticorrosive, epoxy powder coating. A high pressure hose of length 600 mm with foam making nozzle is to be fitted to the body. The material of cap and neck ring shall be stainless steel (as per IS:6529). The refills are manufactured as per IS 4989 (Part-II) : 1984 with ISI marked. The cartridge is manufactured as per IS:4947 – 1985 with ISI mark. The extinguisher will be painted with fire red colour and will be provided with all accessories, wall mounting brackets and screws. The dimensions of neck thread should be in accordance with size G-2\(\frac{1}{4}\) of IS 2643 (part-1) : 19 Extra 2 nos. of 60 gms. CO\(_2\) Gas cartridge shall be provided with each extinguisher. This type of extinguishers shall be provided in all hydraulic room and oil cellars.

i/ Manufacturer’s name

ii/ Year of manufacturing

iii/ Manufacturers serial number

iv/ Purchase Order No. and date

v/ Inspector Stamp.
B. GENERAL SPECIFICATION FOR PASSIVE FIRE PROTECTION

01. INTRODUCTION

Passive fire protection are an integral part of a complete fire protection system and are essential for prevention of spread of fire through openings in walls or floors. These measures are intended to contain a fire in the fire compartment of origin, thus limiting the spread of fire, excessive heat and corrosive, re-ignitable and fatal gases for a limited period of time, as determined by testing, which must bound installed configuration in all respects in order to comply with the law and regulations.

02 TECHNICAL SPECIFICATION

02.01 Fire Retardant Coating/Painting

For vertical run of cables & PVC conduits, fire retardant coating will be provided for the whole length. For horizontal run of cables, 1 m length of fire retardant coating will be provided at every 5.0 m interval wherever cables cross any partition wall, floor or pass through any opening, coating shall be provided for at least 1 m length on either side. In addition to this all the cable joints shall be coated with fire retardant paint all around and or 1 m length fn both the side of joint.

Specification

The Fire retardant coating / painting shall be in-tumescent / ablative, water based compound, supplied in a manufacturer seal container indicating manufacturing and expiry dates. The coating material shall be of water based in-tumescent / ablative compound resistance to hydrocarbon, acid and alkali attack, water and oil resistance and shall have good mechanical strength. It shall not affect capacity of cables and shall last the life of the cable.

Shelf life - 15 to 20 years at room temperature.

Material - Water based in tumescent compound resistant to hydrocarbons, acid, alkali attacks.

Fire rating - Minimum 3 hrs.

Method of Application

Coating shall be applied by ordinary paint brush after cleaning the cables of dust and oil deposition. A minimum textured finish of 1.5 mm to 2.5 mm dry film thickness shall be achieved by
applying the material a few times leaving intervals of at least 4 hours between each coat.

**Test**

Fire coating material should have test certifications for fire survival test, ampacity test, accelerated ageing test, insulation test etc. as per stipulation of CBRI, Roorkee. Approval for the material shall be obtained from CBRI, Roorkee. The material shall be UL/FM approved.

The specification concerning the tests are as follows:

<table>
<thead>
<tr>
<th>Test</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire retardancy test</td>
<td>IEEE 383</td>
</tr>
<tr>
<td>Flammability test</td>
<td>IS:10810 (Part 53)</td>
</tr>
<tr>
<td>Fire survival test, Electrical integrity test</td>
<td>IEC 331</td>
</tr>
<tr>
<td>Tunnel test, Chimney test etc.</td>
<td>ASTM D 2863</td>
</tr>
<tr>
<td></td>
<td>ASTM D 3806</td>
</tr>
<tr>
<td></td>
<td>ASTM E 69</td>
</tr>
<tr>
<td></td>
<td>ASTM D 1230</td>
</tr>
</tbody>
</table>

**02.02 Sealing of Cable Openings**

Cable fire stops/barriers shall be provided in following cases:

a) Entry/Exit area of cable/cable trays in various compartments of cable gallery/basement/tunnels having different fire loads

b) Under control panel/any other panel where cables are entering or going out.

c) In floor openings

These barriers shall provide for effective compartmentalization with a fire rating not less than minimum 3 hrs or fire rating of compartment itself which ever is more. The sealing system should be smoke and gas tight, mechanically sound besides being an efficient fire stop. It shall be possible to take out cables and provide new cables from Fire Stops/barriers at site.

**Components of Fire Stops/Sealing system**

Material shall be such that it will not create too much heat to affect rating of the cables, heat dissipation and cables performance under barrier condition. The system shall be of single component having minimum 3 hrs fire rating (it should have approval from CBRI, Roorkee)
02.03 Testing and Evaluation

The relevant specifications in respect of testing and evaluation of fire stop system are as under. The fire resistance for the door shall be at least 3 hrs duration.

Building Material Testing - BS:476 (Part 8)
Building Construction Material - Fire Testing
- ASTM E 199
Through Penetration Fire Stops - ASTM E 814
Fire Stop Penetration – Fire Test - UL-1479
Fire Tests – elements of building construction - ISO 834
Fire Tests on buildings and structures - IS:3809
Method of Fire Test of Fire Stops - IS:12458
Code of Practice for fire protection of cable runs - IS:12459

Fire Stop materials shall have approval/certification from Govt. recognised laboratories like CBRI Roorkee, RTC, Delhi or ERDA Baroda.

02.04 Partitions in Cable Channels/Tunnels/Galleries

In all cable channels/tunnel/galleries partition walls shall be provided at every 30 m interval. Partition walls shall be constructed of RCC wall and shall have minimum 3 hrs. fire rating. Any openings left out after construction of partition wall shall be sealed with fire stops. Steel Fire doors should be suitably provided.

Steel fire door shall also be provided at every entry/exit of the cable galleries, cable tunnel, cable basement and oil cellars. Fire rating of the door shall be minimum of 3 hrs. All the fire doors shall confirm to IS:3614 and with ISI mark.
C. GENERAL SPECIFICATION FOR HIGH VELOCITY WATER SPRAY SYSTEM (HVWS/WATER MIST SYSTEM) / WATER MIST SYSTEM AND MEDIUM VELOCITY WATER SPRAY SYSTEM (MVWS)

01. SPECIAL INSTRUCTION TO THE TENDERER

It is assumed that the tenderer has studied the specification and satisfied himself regarding the workability of the proposed system and takes full responsibility for the proper system design, best quality of material and workmanship, guaranteed operation and smooth performance of all the equipment and accessories. The Tenderer shall satisfy the Purchaser that he possesses the necessary technical experience for design and has at his disposal suitable facilities and crew to ensure that his work shall be of the best quality and workmanship.

Any loss of plant and equipment after receipt at site due to imprudence, negligence and unsuitable treatment and handling shall have to be replaced by the tenderer at his cost. Any existing services or other property if damaged or demolished during the course of execution either willfully or negligently, shall be re-erected by the tenderer at his own cost.

Existing underground service lines coming in the way of trench excavation etc. have to be supported adequately by the tenderer to avoid any damage at his own cost. Prior approval is to be obtained from the purchaser for excavation wherever any trench/pipe lines are crossing roads. In case of any damage, the same shall be rectified by the tenderer without any cost implication to the purchaser.

The approval of drawings and/or inspection by Purchaser and/or their authorised representative shall not absolve or relieve the Tenderer from any of his obligation under this contract and they shall be wholly and solely responsible for the satisfactory operation and guaranteed performance of the systems and equipment forming part of the system.

This specification is issued for procurement from indigenous sources. No foreign exchange or import licence for importing equipment, components, raw materials or spares will be arranged for or provided by the purchaser. In case the equipment offered involves expenditure in foreign exchange, same shall be arranged by the tenderer.

All material, dimensional standards, tolerances, process of manufacture and testing procedures shall be in accordance with the latest revision of the standard codes specified in this
Specification. In case where such suitable standards are not mentioned, any acceptable Indian/International Standards shall be adopted.

The items described in the specification are indicative and not exhaustive. The Tenderer shall provide all the equipment and material required for the system to complete in all respects.

At the time of award of contract, or at any date preferred by the purchaser the detailed Quality Assurance Plan to be followed for execution of the contract will be mutually discussed and agreed to.

The systems shall be designed & engineered, manufactured, assembled, tested and commissioned as per the standards laid down in this specification. Detailed instructions on such aspects if not indicated shall be as per the latest standards, codes and recommendations of the TAC/NFPA. Where TAC standards are not specific, NFPA or other equivalent international standards shall be used with the approval of Purchaser/ Consultant.

The safety posters/regulation for prevention of accidents shall be displayed by the Tenderer at appropriate places. Notices and warning signs shall be displayed for all sources of dangers. All electrical drives and equipment must be equipped with safety devices. The safety provisions shall conform to the recognised standards, safety codes and statutory regulations. All safety measures as required to be adopted as per the statutory regulations and the safety rules of the plant shall be strictly followed by the Tenderer during the execution of the Contract. Adequate number of first aid boxes as defined in the State Factory Rules shall be provided and maintained at all work sites.

The tenderer shall possess a valid and competent tenderer's licence issued by the Licencing authorities of the State Government for carrying out the type, nature and magnitude of work covered in this specification. Copy of the tenderer’s licence shall be made available to the owner/consultant for verification during execution of contract if required.

All linemen, wiremen, electricians, welders, supervisors and engineers engaged by the tenderer or his sub-tenderer shall possess necessary valid licence issued by the statutory authority and the same shall be submitted for verification, if called for.
02. DRAWINGS AND DOCUMENTS

For Approval by purchaser/consultant after placement of order

i/ G.A Drg. for HVWS/WATER MIST SYSTEM/MVWS system. All system drawings should have approval of TAC / other authorized agency.

ii/ Detailed water requirement calculation.

iii/ G.A. drg. for FWPH showing all piping arrangements & pump sets etc.

iv/ Process and Instrumentation drawing for working of pumps and other equipments in FWPH.

v/ General arrangement drawings for all electrical equipment, showing dimensional and mounting details, cable entry and front view details.

vi/ Pipes, Cable and conduit routing drawings.

vii/ Power and control circuit diagram for panels/equipment.

viii/ Hydraulic calculation

Drawings/documents to be furnished for information by the tenderer

a/ Manufacturer's routine test and type test certificates for all equipment and cables.

b/ Detailed technical catalogues/data sheet/brochure for all the equipment.

c/ Ordering specifications to sub-suppliers.

d/ Instruction manuals for erection, maintenance and operation of all the equipments.

As built drawings/documents

The Tenderer shall submit following As Built drawings/documents in five sets.

- All approved drawings/documents
- All test charts and inspection certificates in bound volume.
- CAD version of drawings
03. **INSPECTION**

The tenderer has to submit an inspection procedure for all items to be supplied by him within 4 weeks of placement of order. The inspection procedure shall be finalised and approved by the purchaser.

No equipment or part item shall be despatched without provisional acceptance certificate and despatch instructions issued by the purchaser.

All equipments, assemblies and subassemblies shall be shop tested as per relevant standards and test certificates to be submitted by the tenderer. Purchaser's representatives and personnel from Fire Department shall have the option to visit the place of manufacture for joint stage inspection. All equipments shall be inspected by the purchaser before despatch of the equipment. The tenderer has to make all arrangements for providing the necessary tools, tackles and instruments free of cost to carry out the inspection.

04. **DESCRIPTION OF THE SYSTEM**

HVWS/WATER MIST SYSTEM & MVWS envisaged is a special fixed pipe system connected to a reliable supply of adequate quantity of water and equipped with spray nozzles (projectors) for specific water discharge and impingement over the surface or area to be protected. The piping system is to be connected to the water supply through an automatically actuated valve (deluge valve) which can initiate flow of water. Deluge valves for the spray system are to be actuated by an automatic detection system which in the case of transformers consists of quartzoid bulb detectors mounted around the protected area and for cable galleries these are part of fire detection & alarm system. HVWS/WATER MIST SYSTEM / Water Mist system shall be installed for protection of transformer. Cable galleries/basements shall be protected by MVWS system. All instrumentation points actuated by the FDA system shall be addressable and controlled by FDA panel.

05. **MAIN COMPONENTS OF THE SYSTEM**

The HVWS/WATER MIST SYSTEM/MVWS System shall be provided with the following major components:

a/ Water Supply at high Pressure
b/ Arrangement of Spray Nozzles
c/ Arrangement of Quartzoid Bulb Detectors (for HVWS/WATER MIST SYSTEM)
d/ Deluge Valve
e/ Y-type Strainers just before deluge valve
f/ Pipes, fittings and fixtures
g/ Basket strainers in HVWS/WATER MIST SYSTEM header
i/ Pressure gauges, pressure switches and solenoid valves
j/ Fire detectors
k/ De-watering pumps

06. OPERATION OF THE SYSTEM

Initially, delivery line should be pressurised upto deluge valve with the help of electrically driven Main Pump/Jockey pump and the water line pressure upto deluge valve should be maintained at around 8.8 Kg/cm². The Q.B. detector line should be pressurised to a pressure of 4 Kg/cm² with help of water which should be tapped from the header itself. Deluge valve clack is kept in horizontal position in normal condition due to balanced hydraulic pressure on two sides of the clack.

In case of transformer fire, temperature will rise all around the transformer. On reaching a predetermined temperature (generally 30°C above ambient temperature) quartzoid bulb detectors, which are installed on pressurised water line (water for which is tapped from the main header itself), will shatter. As the bulb shatters, water in the detector line gets released through the detector openings and water pressure in detection line drops rapidly. This results in creation of pressure differential in the deluge valve and leads to latter's actuation. During this operation pressure in the water delivery line falls rapidly resulting in start up of main electrical driven pump. In case of power failure, pressure in the header shall go on decreasing causing start up of diesel engine driven pump.

In case of cable galleries the actuation of deluge valves are effected by signal from fire detection and alarm system provided in the premises. Cable galleries shall be provided with multi criteria combination of rate of rise heat detector and photoelectric smoke detector. These have been described in detail in FDA specification. In the event of fire in the premises, the detection system shall give signal to Main Fire Alarm Panel (MFAP) which in turn shall actuate the solenoid of the deluge valve concerned. There shall be provision for manual operation of the system also by operating quick opening valves of each deluge valve.
07. **DESIGN CRITERIA**

Following salient parameters shall be followed for the design of the system.

i/ Water application rate for HVWS/WATER MIST SYSTEM - 10.2 lpm/m² of the surface area of the entire transformer including bottom surface, radiators etc. For MVWS in cable galleries, 6.1 lpm/m² on each tray. The working pump capacity shall be decided based on the water requirement (whichever is higher) and selection of pump shall be from TAC approved pump capacities. The capacity of water reservoir shall be equal to at least one hour pumping.

ii/ The system shall be so hydraulically designed that the pressure at the hydraulically most remote projector in the network shall not be less than 3.5 bars for outdoor transformer and 2.8 bar for indoor installations. For cable galleries also Pressure at remotest sprayer - not less than 2.8 bars.

iii/ Velocity in the feed pipe shall not be more than 10 m/s.

iv/ The header shall be laid under ground and tappings for the individual deluge valve shall be taken there from.

v/ Q.B. detectors shall be installed in rings as per TAC norms around the protected area. Maximum spacing between detectors shall be 2.5 m.

vi/ Projectors (for transformers) shall be installed in rings encircling the protected area. One ring shall be provided at the top and subsequently rings for every 3 m from top to bottom shall be provided. The spares shall be installed in rows at the central aisle between the cable tray and spaced at not more than 2.5 m from each other.

iv/ There shall be common header for HVWS/WATER MIST SYSTEM and MVWS systems which shall be fed water from the pump dedicated for the spray system. The hydrant header and spray system (HVWS/WATER MIST SYSTEM & MVWS) headers shall be inter-connected with a non-return valve in between so that hydrant system can be a back-up for the spray system.

v/ In cable galleries, the protected area shall be divided into several zones, each of which shall be fed by individual deluge valve. In event of fire, water shall be sprayed on the zone concerned (i.e. zone under fire) along with
preceding and succeeding zones. Zone lengths for cable galleries shall be 30 m.

vi/ Distribution of sprayers in cable galleries: The sprayers shall be installed in rows at the central aisle between the cable trays and spaced at not more than 3 m from each other.

08. **EQUIPMENT SPECIFICATION**

08.01 **Deluge Valve Assembly**

Deluge valve assembly functions on differential pressure operation allowing quick opening of the valve and thereby rush of water to the protection system. The valve consists of inlet, outlet and priming chamber. The inlet and outlet chambers are separated from the priming chamber by the valve chamber and a diaphragm. In the 'Set' position, pressure is applied to the priming chamber through a restricted prime line. The pressure is trapped in the priming chamber and holds the clapper on the seat due to the differential design. In the 'Set' position the clapper separates the inlet from the outlet keeping the system piping dry. When the pressure is released from priming chamber, the clapper moves and allows the inlet water supply to flow through the outlet and to the fire extinguishing system. All component / equipment of the system including Deluge valve shall be UL / FM approved and marked.

The deluge valve assembly will consist mainly of the following:

- Isolation valves on both upstream and downstream sides.
- Inline strainer
- Deluge valve proper
- Actuator/pilot assembly
- Drain valve
- Pressure gauges
- Solenoid valve
- Deluge valve housing

The deluge valve shall be of resetting type, taking minimum time for resetting. The deluge valve shall be UL/FM approved make.
08.02 **Spray Nozzles (Projectors and sprayers)**

Water spray nozzles for the system shall be of suitable orifice size and varying discharge angles to cover fully all the area supposed to be protected. The nozzles shall be of Gunmetal with Nichrome finish or Stainless steel. The nozzles shall be normally open type, Spray nozzles (projectors) shall bear UL/FM approvals.

08.03 **Strainer**

Y type strainer shall be provided on the inlet side of each deluge valve assembly. The strainer shall prevent deposition of foreign particles in the valves and thereby malfunctioning of control valves. The material of construction of the strainer shall be gun metal and it will bear TAC/IS approval.

08.04 **Quartzoid Bulb Detectors**

The Q.B. detectors shall bear TAC/UL/FM approval and shall have a temperature rating of minimum 79 degree centigrade. However the tenderer shall take into account the temperature at which they shall operate.

08.05 **Pipes, Valves & Fittings**

Pipes and pipe fittings in general shall comply with the requirements of BIS codes. Piping layout must follow good engineering practice. Proper attention shall be given to obtain full functional requirement of piping system with a layout which provides sufficient clearance for other equipment and other personnel and easy access for operation and maintenance.

All piping shall be complete in all respects and shall consist of necessary valves, fittings, supports, air release and drain valves and other accessories. The air release and drain valves shall be provided at high and low points respectively. Each of the branch connection taken from the network shall be provided with an isolation valve.

Wherever over-ground pipelines are crossing roads and railway tracks, they shall be laid on pipe bridges to provide the necessary clearance for the traffic movement. A minimum clear height of 6.0 m above road top level shall be maintained.

All pipe work shall be designed to provide complete flexibility to prevent development of undesirable forces or moments at points of connection to equipment, at anchorages or at guide points, due to thermal expansion. Flexibility shall be provided by changes of direction or by use of bends, loops, offsets etc.
The specification of pipes are as below.

**T.S. for Pipes between deluge valve and main header**

i) Upto 150 mm nominal size - M.S ERW Black pipes conforming to IS-1239-1984 Part-I (heavy grade) With Plain ends.

ii) 200 mm to 400 mm size - M.S. ERW Pipes conforming to IS-3589 1973 but thickness as specified below

**Nominal Dia  O.D X Thickness in mm**

- DN 200 mm : 219.1 x 6.35
- DN 250 mm : 273.0 x 7.14
- DN 300 mm : 323.9 x 7.14
- DN 350 mm : 355.6 x 7.14
- DN 400 mm : 406.4 x 7.14

**T.S. for Pipes and valves after deluge valve**

The material of construction and manufacturing standard of pipes, fittings, valves, fasteners, gaskets, etc. shall be as described in table below:-
## Table

Nominal pressure (PN) - 10 Kg/Cm²  
Test Pressure (PT) - 15 Kg/Cm²

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Items</th>
<th>Nominal dia.(mm)</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pipe</td>
<td>65 and below 80</td>
<td>IS-1239 (Part-1) - 'Heavy, G.I. IS-1239 (Part-1) - Medium, G.I. IS-3589 Gr.410 ERW pipe commercial quality or equivalent. Thickness same as in clause 11.02 (ii) above.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 to 150</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 to 450</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Pipe fittings</td>
<td></td>
<td>A 234 Gr. IS-1239/3589/2062</td>
</tr>
<tr>
<td>2.1</td>
<td>Screwed fittings</td>
<td>65 &amp; below</td>
<td>IS-1239 (Part-1) - Galvanised</td>
</tr>
<tr>
<td>2.2</td>
<td>Fabricated fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bends</td>
<td>150 and above</td>
<td>Mitred bends with radius 1.5 DN from black pipe.</td>
</tr>
<tr>
<td></td>
<td>Tees/Crosses</td>
<td>150 and above</td>
<td>Fabricated from black pipes by smithing.</td>
</tr>
<tr>
<td></td>
<td>Reducers</td>
<td>150 and above</td>
<td>Fabricated from black pipes by taper cutting and welding.</td>
</tr>
<tr>
<td>3.</td>
<td>Bolting</td>
<td>All sizes</td>
<td>IS - 1367</td>
</tr>
<tr>
<td>4.</td>
<td>Gaskets</td>
<td>All sizes</td>
<td>Sheets rubber to IS-635- <code>79 type-A, 3 mm thick compressed Asbestos to IS-2712-</code>79</td>
</tr>
<tr>
<td>5.</td>
<td>Flanges</td>
<td>All sizes</td>
<td>Slip on flanges to IS-6392 - <code>71 machined from Carbon Steel plates to IS-2002- </code>92 Gd. 2 with bore to suit pipe O.D.</td>
</tr>
<tr>
<td>6.</td>
<td>Valves</td>
<td>Isolation 50 &amp; below</td>
<td>CI gate valves, screwed, as per IS-780 - `84 class - PN - 1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 to 300</td>
<td>CI gate valves, flanged as per IS- 780-84 class - PN - 1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>350 and above</td>
<td>CI gate valve, flanged as per IS-2906-`84, Class - PN - 1.6</td>
</tr>
<tr>
<td></td>
<td>Throttling</td>
<td>50 and below</td>
<td>Gunmetal globe valve, Screwed, as per IS-778-`84 Class-2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 to 300</td>
<td>CI globe valve with brass/bronze renewable seat rays flanged.</td>
</tr>
</tbody>
</table>
Valves

Valves shall be provided on pipe work for stopping and starting of flow, controlling flow rate, diverting flow, preventing back flow, controlling pressure, relieving pressure and for venting and draining of pipelines etc.

Valve selection shall be made based on the following considerations:
- Suitability of valve materials in regard of properties of fluids, temperature, pressure, erosion and shock.
- Valve size.
- Main function of the valve (viz. throttling, stop, permitting flow in one direction, diverting flow, relieving pressure etc.)
- Friction head losses.
- Ease of operation, i.e. method of actuation-closing time.
- Maintenance considerations.

The valves to be provided shall include but not be limited to the following:
- Isolation valves on the main header at various locations.
- Gate valves in the branch pipes from header to DV and from DV to the served area.
- NRV on all pipe lines requiring unidirection flow only.
- Quick opening safety shut off valves.
- Manual drain valves.

08.06 Pipe supports and fixtures

Necessary pipe supports & fixture, pipe thrust block or pipe bridge to run the pipes overhead/underground or in the pipe trench as the case may be, shall be included in the scope of the tenderer. The tenderer shall study the location of protected premises and their auxiliary equipment and accordingly plan the pipe routing and the location of spray nozzles, deluge valves and manually operated valves. The fire protection equipment and the fixtures located in the vicinity of the transformers should not pose any operational problem. At places, where no supports/trenches are available the
tenderer shall consider dedicated supports required for the pipe lines/spray nozzles etc. for the system.

08.07 **Equipments in Fire water pump house**

All equipments to be installed in the Fire water pump house (FWPH), viz., Main Pumps, diesel engine driven standby pumps, jockey pumps, valves, hoisting facilities, ventilation fan, instrumentation gadgets etc. have been described elsewhere in the package specification. Major facilities are enumerated below:

i) Horizontal Centrifugal Fire Water Pump (the pump shall be connected to alternate power supply). All the pumps shall be of positive suction.

ii) Electric drive motors mounted on the drive support of the pump, complete with terminal box for armoured cables and the Motor leads, Tilting pad thrust bearing / antifriction bearing and Accessories for one no. of the above pumps.

iii) Diesel Engine drives with associated battery & charger

v) Fire water jockey pumps

vi) Electric drive motors mounted on the drive support of the pump, complete with terminal box for armoured cables and the Motor leads, Tilting pad thrust bearing/ antifriction bearing and Accessories for Two Nos. of the above jockey pumps.

vii) Complete set of foundation Bolts, Nuts, Base-plate, Soleplate and Steel embedded parts.

viii) All necessary integral sensors required for the pump and drive motor, including discharge pressure gauges.

ix) Complete lubrication system together with grease fittings and initial fill of lubricants for thrust bearing, foam concentrates, diesel and consumables etc.

x) Ventilation facilities (axial fan) for the fire water pump house.

xi) Hoisting facilities of adequate capacity for FWPH complete with electrics, all structural members and other accessories.
xii) Piping inside pump house, gate valves, non-return valves, cabling, instrumentation and other accessories.

xiii) Complete electrics and instrumentation for all equipments in FWP.

08.08 **Deluge valve housing**

Deluge valve room/housing shall be provided to protect the deluge valve and other equipment and accessories from mechanical damage as well as environmental condition. Deluge valve housing shall be provided as per TAC norms.
D. GENERAL SPECIFICATION FOR CARBONDIOXIDE SYSTEM / FOAM SYSTEM & CLEAN AGENT SYSTEM

01 SPECIAL INSTRUCTION TO THE TENDERER

01.01 It is assumed that the tenderer has studied the specification and satisfied himself regarding the workability of the proposed system and takes full responsibility for the proper system design, best quality of material and workmanship, guaranteed operation and smooth performance of all the equipment and accessories. The Tenderer shall satisfy the Purchaser that he possesses the necessary technical experience for design and has at his disposal suitable facilities and crew to ensure that his work shall be of the best quality and workmanship. Any loss of plant and equipment after receipt at site due to imprudence, negligence and unsuitable treatment and handling shall have to be replaced by the tenderer at his cost. Any existing services or other property if damaged or demolished during the course of execution either willfully or negligently, shall be re-erected by the tenderer at his own cost.

01.02 The approval of drawings and/or inspection by Purchaser and/or their authorised representative shall not absolve or relieve the Tenderer from any of his obligation under this contract and they shall be wholly and solely responsible for the satisfactory operation and guaranteed performance of the systems and equipment forming part of the system.

01.03 This specification is issued for procurement from indigenous sources. No foreign exchange or import licence for importing equipment, components, raw materials or spares will be arranged for or provided by the purchaser. In case the equipment offered involves expenditure in foreign exchange, same shall be arranged by the tenderer.

01.04 All material, dimensional standards, tolerances, process of manufacture and testing procedures shall be in accordance with the latest revision of the standard codes specified in this Specification. In case where such suitable standards are not mentioned, any acceptable Indian/International Standards shall be adopted.

01.05 The items described in the specification is indicative and not exhaustive. The Tenderer shall provide all the equipment and material required for the system to complete in all respects.

01.05 At the time of award of contract, or at any date preferred by the purchaser the detailed Quality Assurance Plan to be followed for execution of the contract will be mutually discussed and agreed to.
01.06 The systems shall be designed & engineered, manufactured, assembled, tested and commissioned as per the standards laid down in this specification. Detailed instructions on such aspects if not indicated shall be as per the latest standards, codes and recommendations of the TAC/NFPA.

01.07 The safety posters/regulation for prevention of accidents shall be displayed by the Tenderer at appropriate places. Notices and warning signs shall be displayed for all sources of dangers. All electrical drives and equipment must be equipped with safety devices. The safety provisions shall conform to the recognised standards, safety codes and statutory regulations. All safety measures as required to be adopted as per the statutory regulations and the safety rules of the plant shall be strictly followed by the Tenderer during the execution of the Contract. Adequate number of first aid boxes as defined in the State Factory Rules shall be provided and maintained at all work sites.

01.08 The tenderer shall possess a valid and competent tenderer's licence issued by the Licencing authorities of the State Government for carrying out the type, nature and magnitude of work covered in this specification. Copy of the tenderer's licence shall be made available to the owner/consultant for verification during execution of contract if required.

01.09 All linemen, wiremen, electricians, welders, supervisors and engineers engaged by the tenderer or his sub-tenderer shall possess necessary valid licence issued by the statutory authority and the same shall be submitted for verification, if called for.

01.10 **Instruction Manuals**

a/ Instruction manual shall give step by step procedure for:

- Erection, testing and commissioning
- Operation
- Maintenance and
- Repair.

b/ Maintenance instruction shall include:

- Diagnostic trouble shooting/fault location charts.
- Tests for checking of proper functioning.
Instruction manual shall also contain:

- Manufacturer's catalogues with ordering specification for all items.

- List of consumables with specifications, brand names and annual consumption figures.

- Drawings relevant for erection, operation, maintenance and repair of the equipment.

- Procedure for ordering spares.

02. DRAWINGS AND DOCUMENTS

For Approval by purchaser/consultant after placement of order

i/ G.A Drg. for the system. All system drawings shall have approval of TAC / other authorized agency.

ii/ Detailed gas requirement calculation.

iii/ Process and Instrumentation drawing

iv/ General arrangement drawings for all electrical equipment, showing dimensional and mounting details, cable entry and front view details.

v/ Pipes, Cable and conduit routing drawings.

vi/ Computerised flow and pressure calculation

Drawings/documents to be furnished for information by the tenderer

a/ Manufacturer's routine test and type test certificates for all equipment and cables.

b/ Detailed technical catalogues/data sheet/brochure for all the equipment.

c/ Ordering specifications to sub-suppliers.

d/ Instruction manuals for erection, maintenance and operation of all the equipments.

As built drawings/documents

The Tenderer shall submit following As Built drawings/documents in five sets.
3. **INSPECTION**

The tenderer has to submit an inspection procedure for all items to be supplied by him within 4 weeks of placement of order. The inspection procedure shall be finalised and approved by the purchaser.

No equipment or part item shall be despatched without provisional acceptance certificate and despatch instructions issued by the purchaser.

All equipments, assemblies and subassemblies shall be shop tested as per relevant standards and test certificates to be submitted by the tenderer. Purchaser’s representatives / personnel from fire dept. shall have the option to visit the place of manufacture for stage inspection. All equipments shall be inspected by the purchaser before despatch of the equipment. The tenderer has to make all arrangements for providing the necessary tools, tackles and instruments free of cost to carry out the inspection.

4. **SYSTEM DESCRIPTION**

The total flooding system of CO₂ or Clean agents work on the principle of making the premises non-conducive to sustenance of fire therein by injecting sufficient quantity of gas. The rapid injection of sufficient volume of gas into an enclosure, so that an inert atmosphere is created, extinguishes fire, which is named as total flooding system.

Carbon-di-oxide is a colorless electrically non-conductive gas that is suitable for extinguishing fire where water or foam can not be used and where clearing up after fire extinguishment present problems. CO₂ total flooding system shall be only provided in hydraulic cellars / oil cellars / lubrication rooms and oil tunnels etc. along with automatic detectors (Intelligent type).

**Tenderer shall also consider automatic high expansion foam system in place of CO₂ total flooding system as alternative fire fighting measure for oil cellars in their offer. The final recommendation for one of the above system shall be indicated during the tender discussion.**
Clean agent gas like Inergen IG-541 / IG-55 as per IS:15501-2004 and IS:15506-2004 respectively for Gaseous Fire Extinguishing System and also conforming to NFPA-2001, shall be used in PLC room, Computer rooms and important control rooms. Preferably VESDA/VIEW shall be provided in computer room / PLC / UPS room and control room. **This clean agent system shall be supplied with multi criteria detectors.**

The discharge of Carbon dioxide may create hazards to personnel especially in the case of total flooding system. It is necessary to provide suitable safeguards to ensure prompt evacuation from and prevention of entry into the space where CO₂ will be discharged.

When detectors detects fire, the signal is communicated to the main control panel, which shows the address (along with location) of the actuated detector. On detection of fire the respective hooters of the zone will also be actuated. On confirmation of fire by detectors the respective Air-conditioning & Ventilation system will trip and evacuation alarm signal will appear in the premises provided with CO₂/Clean agent system. There will be a selector switch for manual and automatic actuation of the system. Gas will be discharged automatically in the affected premises after a time lag of 30 seconds. In case of manual operation, after time lag of 30 seconds the push button switch of the affected premises shall be manually operated which will actuate the discharge of CO₂ gas developing required concentration and there by extinguishing the fire.

Further, if manually operated push button system in inoperative due to any reason, CO₂/Clean agent can be discharged by manual lever provided for the purpose.

Each system shall have equal number of reserve cylinder complete with all accessories. All instrumentation points actuated by the FDA system shall be addressable (intelligent) and controlled by FDA panel.

05. **DESIGN CRITERIA**

05.01 **CO₂ Total Flooding or Clean Gas Agent System**

05.01.01 Carbon-di-oxide/Clean gas agent system required above shall be designed as per the requirement of National Fire Protection Association's code 12 (NFPA, USA) and IS code 6382 - 1990. Clean agent based automatic fire protection system shall be designed as per NFPA-2001. The design, manufacture, testing and performance of all the critical equipment and components
covered in this specification shall be UL / FM / approved and listed therein. The quality of carbon dioxide (CO₂) shall conform to IS:307. All major components of the system except pipes, cables and support structures etc. shall have UL / FM approved.

05.01.02 The quantity of gas required for the system shall be based on the gas required to blanket the volume of area protected and the time that the discharge must be maintained to assure complete extinguishing of fire (30 seconds for CO₂ and 10 sec for clean agent) after actuation.

05.01.03 In order to optimize the requirement of gas and considering the space for cylinder banks, it may be planned to club together requirements of two or more adjacent premises. The tenderer shall ensure that the appropriate logic is followed for discharge of gas in respective premises.

05.01.04 Tenderer will include provision for automatic actuation of the system by FDA in the premises concerned. Annunciation for system operated will be provided in MFAP and Annunciation panel. Provision for time delay and evacuation alarm shall also be given. The FDA Panel shall have necessary Hardware and software to activate (operate) Automatic fire extinguishing system provided with directional valves (if applicable) for different zones / premises.

05.01.05 The tenderer shall size the pipe accordingly to achieve the design concentration of gas required for extinguishing the fire in the premises.

05.01.06 The concentration level shall not exceed the NOAEL and LOAEL level as per NFPA guidelines.

05.02 Equipment Specification

05.02.01 Each system in general shall consist of the equipment not limited to the following for successful operation:

- Bank of Carbon-di-oxide/ Clean agent cylinders each fixed with cylinder head valve and non-return valve.
- Bank of standby cylinders fitted with - cylinder head valves connected with manifold.
- Gas manifold and high-pressure hoses.
- Pressure operated control valves.
- Pilot cylinders with firing unit (electrical actuator)
- Discharge nozzles
- Manual release push button
- Pipes and fittings
- Fire detection and alarm system
- Caution hooters
- In-situ weighing arrangement for cylinders
- Caution boards & evacuation alarm
- Inhibitors
- Safety relief valves

05.02.02 Cylinder Bank

The required quantity of gas will be stored in seamless steel cylinders confirming IS: 7285 duly approved by CCE, Nagpur. Each cylinder shall be provided with gas release device all suitably connected to the gas manifold which will discharge the gas in protected premises in case of any outbreak of fire. The total number of cylinders in the bank shall be determined depending upon the area/volume of the protected premises and the capacity of individual cylinders. All cylinders in the bank shall be inter-changeable. Equal number of standby cylinders shall also be provided to be used after depletion of main cylinder bank and connected to the main header so that in case of successive fires the reserve bank can be used to put out the second occurrence of fire.

05.02.03 Gas Manifold

Each cylinder in the bank shall be fitted with a discharge head, which shall be connected to a common manifold through high pressure connecting pipes of tubes. In case rigid pipes are used for the purpose anti-vibration coils shall be provided.

All cylinders in the battery and the common manifold shall be mounted and suitably supported in a rack provided for the purpose. The rack shall be designed in such a manner that servicing and checking of individual cylinders shall be convenient and the cylinders are rigidly held in position. The design shall ensure no chance/minimum possibility of accidental discharge of cylinders.

05.02.04 Discharge Heads and Valves

All valves under constant high pressure shall have a minimum bursting pressure of not less than 420 kgf/sq.cm and those not under constant pressure shall have a bursting pressure of not less than 350 kgf/sq.cm.

Discharge heads and valves shall be designed to permit a minimum discharge of 85 percent of the carbon-di-oxide in the cylinder in not more than 30 second at a temperature of 27 + 1°. The discharge rate of carbon-di-oxide shall be not less than 0.68 kg/second for the first 85 percent of the cylinder’s content.
All discharge heads and valves shall be so arranged that these shall no be susceptible to mechanical, chemical or other damage.

05.02.05 Discharge Nozzles

Discharge nozzles shall be sufficient in number as per IS/NFPA norms and so located that the gas discharge pattern shall completely cover the protected area house having adequate concentration in the high hazard locations.

05.02.06 Pipes and Fittings

All pipes and fittings, including the manifold shall have a minimum bursting pressure of 350 kgf/sq.cm. The complete distribution system shall be free from leakage when tested at a pneumatic pressure of 140 kg/sq.cm. with all nozzles outlets closed.

All sections of pipes having dead ends shall be fitted with suitable pressure relief devices designed to operate between 168 kg/sq.cm. and 210 kg/sq.cm.

The pipes shall be of ASTM A-53 or A-106 type (Seamless Carbon Steel High Pressure Sch. 80 pipe).

05.02.07 Lock Off Device (Inhibitor)

Each system shall incorporate a suitable locking device to make the system inoperative before undertaking any repair/maintenance within the protected area. The system shall be capable of putting on normal operation after completion of the repair/maintenance work.

05.02.08 Caution Sign

Necessary caution displays in the form of Audio-visual type indicating the hazards of carbon-di-oxide flooding shall be installed at strategic places of the premises provided with total flooding system.

The visual display shall be of flashing type and the audio hooter/siren shall be of distinct tone and capable of being heard in the range of 500 m from the source.
05.02.09 Material of Construction

Cylinder Valve - Bronze/GM
NRV - Brass
High pressure hoses - Copper
Spray nozzles - LTB

05.03 Automatic High Expansion Foam System

05.03.01 The hydraulic cellars / oil cellars / lubrication rooms and oil tunnels etc. of proposed expansion facilities are to be protected by automatic fixed high expansion foam system. The system shall consist of foam storage tanks, inline foam inductors, foam generators, jockey pump, main electrically driven pump, main diesel driven pump, pipes, valves and an automatic fire detection system. The main electrically driven pump main diesel driven pump and the jockey pump are to be housed in the pump house. Normally the jockey pump will keep the system under pressure upto the electrically operated valve located near the respective oil cellar. Foam concentrate storage tank. Inline inductor, electrically actuated valve etc. will be located near the foam generator for the respective oil cellar. On receipt of fire signal form the fire detection system to discharge water for making foam solution near the cellar. The foam solution thus formed is passed through the foam generators which will produce high expansion foam and flood the oil cellar within approximately 4 minutes time. Necessary repeater panels are to be provided fire indication at specified locations.

05.03.02 In line Inductors

The inline inductor shall be suitable to proportion the water and foam concentrate with 1.5% proportioning. The inline inductor shall be made up of stainless steel so as to avoid any corrosion effects of the foam concentrate. The inlet and outlet diameters of the inline inductor shall be suitably designed to match the system demand requirements. Suitable strainers shall be provided prior to making foam solution on the pipe lines.

05.03.03 Foam Concentrate Tanks

Foam concentrate tanks of following capacities are to be provided with an initial fill of high expansion foam concentrate near each of the oil cellars.

The tanks shall be made out of 5 mm thick stainless steel sheets and shall be cylindrical in shape and installed vertically. Suitable arrangement shall be made to mount the tank on the floor by utilizing minimum possible area. the tank shall be provided with
foam concentrate supply connection to the inline inductor, fill connections with funnel, drain valves and pressure vent. The inside surface of the tank shall not be painted however, the external surface of the tank shall be painted with 2 coats of primer and one coat of yellow paint. The paint used shall be as per the Indian Standards and shall be corrosion resistant. The foam concentrate shall have the following characteristics:

Induction rate - 1.5 %
Expansion Ratio - 1:750 to 1:1000
(It will very depending upon the design and manufacturer’s recommendations.

05.03.04 High Expansion Foam Generators

The approximate capacity of foam generators for each cellar shall be indicated in the offer. However, the capacity of the foam generators may be varied to suit the pump capacity based on the type of generator quoted and taking into account that the largest cellar is to be flooded within a period of 4 minutes. The foam generator shall be water driven type and shall not use any other sources of power for its movement.

The foam generators shall be made out to the following materials for the specified parts:

- Body: Stainless Steel
- Pipe work & nozzles: Stainless Steel
- Impeller: Aluminium epoxy painted
- Turbine: Gun metal body and stainless steel shaft
- Foam making net: Stainless steel

The foam generators shall be independent of foam inductors system. Suitable supports / brackets shall be supplied for fixing the foam generators in position.

The requirement of above table under para 6.00.

05.03.05 Piping and Supports

All the pipings, fittings and all accessories shall be same as indicated in clause no. 08.05 of chapter D for HVWS / MVWS.

However the exposed piping till electrically actuated valves shall be of mild steel galvanized conforming to IS : 1239 Medium grade and bearing IS approval. All the exposed piping conveying foam solution from foam concentrate onwards shall be of stainless steel conforming to latest IS Specification.
05.03.06 Miscellaneous Items

The tenderer shall include all necessary bolts, nuts, brackets, hangers, supports, companion flanges etc., for completing the system in all respects. The paint shall conform to Indian Standard and shall anti-corrosive.

05.04 Low Expansion Foam System

05.04.01 All the oil tanks in premises of expansion area shall be protected by low expansion foam system. The system shall confirm to NFPA norms.

06. ELECTRICS

Tenderer to include power supplies and control interlocking as described in this chapter. All wiring - junction boxes, push button station, indication lamps, hooters etc. for all above systm shall be included into scope of tenderer. All areas CO₂ system shall have illuminated board "FIRE - EVACUATE CO₂ WILL BE FLOODED". Each area shall have hooter adjacent to illuminated sign.

Main fire Alarm Panel shall have annunciation for fire in above areas and after confirmed signal (operation of two detectors) signal will be initiated for tripping of A/C system and visual indication ‘START - FLOODING’ shall be there. From Main Fire Alarm Panel signals shall also be initiated for illuminated sign/hooters of respective area.

07. FIRE DETECTORS (PART OF FIRE DETECTION & ALARM SYSTEM)

Detectors have been described in detail elsewhere in the package specification.

Following types of detectors shall be used for automatic actuation of MVWS/HVWS/High/Low expansion foam system:

Cable galleries / HVWS / MVWS / High / Low Expansion Foam System / Computer Rooms / CO₂ System in Oil Cellars and Hydraulic Cellars: Detector shall be multi criteria combination of rate of rise heat detector and photoelectric smoke detector.

Transformer: QB detector

Date of manufacturer / installation shall be marked on each detectors.
Manual push button of each area shall be located near exit and shall be break glass type with attached hammer. Manual push button shall operate valve for flooding in respective premises and as well as for connecting banks of gas cylinders to main pipe for CO₂ / clean gas agent system.

Tenderer to develop logic for above and submit working scheme along with the tender. Any interface devices required to hook up this system with the Main Fire Alarm Panel shall be included by the tenderer as part of the scope as a whole.

1 No. Wall mounted annunciation board near cylinder bank shall be provided for (duplicate) annunciation to facilitate manual operation of valves.
E. DESIGN CRITERIA FOR WATER BASED FIRE-FIGHTING SYSTEM

01. HYDRANT SYSTEM

01.01 Fire water pump houses shall be provided with required nos. of electric motor driven pump sets, diesel engine driven pump sets and jockey to cater to the needs of the water based fire-fighting system an independent fire fighting network with all associated electric, instrumentation piping handling and hoisting facilities etc. shall be provided. in line with the NFPA – 20, FM, UL, TAC requirement 2003. Also a wet riser ring main shall be provided which will cover the complete plant complex.

01.02 The fighting pumps and accessories will be housed in a separate fire fighting pump house.

01.03 Internal hydrant shall be located at 30m interval and external hydrant shall be located at 45m interval

01.04 Internal hydrant shall be provided on all the floors of the buildings, Junctions houses, office building, conveyor galleries, other process building etc.

01.05 A fire water storage reservoir of adequate capacity (Minimum 2 hr requirement or as specified) shall be provided.

01.06 Filling connection to fire water reservoir shall be provided from the proposed make-up water line for the plant complex.

01.07 The detail specification of Fire water pump, diesel engine and hydrants are specified below :-

02. FIRE WATER PUMP

i) The centrifugal pumps shall be suitable for discharging not less than 150% of the rated capacity at a head of not less than 65 % of the rated head. The Shut off head shall not exceed 120% of the rated head.

i) Specification and details as specified for horizontal centrifugal pumps in this specification shall also be applicable for fire water pump.

ii) Horizontal centrifugal fire water pump (electric driven) shall be connected to alternate power supply.

iii) All the pumps shall be in positive suction.
03. **FIRE HYDRANT**

Landing valve/ yard hydrant shall be as per IS: 5290, Type-A.

The hose cabinet shall be fabricated out of fiber reinforced plastic (thickness 2.5 mm) of size 750 mm x 600 mm x 250 mm. The top shall have pressed edge slightly projecting outside to prevent water (while cleaning etc.) from entering the cabinet. The cabinet shall be fitted with glass fronted door. The door shall be provided with a knob and a lock with duplicated key on the body of the door with a glass cover. The glass of the key box shall be easily replaceable. Suitable hooks, etc, shall be provided in the cabinet to hold the hose reels etc. mentioned above. Suitable wall mounting bracket shall be provided with the cabinet. The Tenderer shall provide a fully dimensioned general arrangement drawing indicating materials of construction, relevant specifications, etc. General specification of Hydrants to be provided by the Tenderer is given below. However, the quantities of all the items will be provided by the Tenderer as per requirement and approval of Purchaser/Consultant without any price implication.

Each hydrant shall be provided with 15m long delivery hose (Type B IS636) with SS coupling and accessories.

### 03.01 Specification of Fire Hydrants and Accessories

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>IS no.</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>INTERNAL HYDRANT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>IS:5290 Type-A (1993)</td>
<td>Fire hydrant (landing valves) single outlet oblique type of 75mm flanged inlet, 63mm outlet with hand wheel, Instantaneous bronze female coupling at outlet and blank cap. (Stainless Steel)</td>
<td>As per TAC requirement (to be indicated by the Tenderer)</td>
</tr>
<tr>
<td>2.</td>
<td>IS:6392 Table-18 (1971 R.A.1988)</td>
<td>MS matching flange DN 80 (Slip-on type) with bolts, nuts &amp; gaskets for the above hydrants</td>
<td>-do-</td>
</tr>
<tr>
<td>3.</td>
<td>Hose cabinet with glass front (for indoor installation, One number hose box for each landing valve to keep 7.5m long hoses (2 Nos.) branch pipe, nozzle and spanner) consisting of the following:</td>
<td>-do-</td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>IS:636 Type-B (1988) &amp; IS:903 (1984 R.A.-1990)</td>
<td>Reinforced rubberised fabric lined flexible canvas hose of 15 m length having 63mm dia, each fitted (as per IS:1648:1961) with instantaneous male Coupling at one end and female Coupling at the other end.</td>
<td>-do-</td>
</tr>
</tbody>
</table>
## STEEL AUTHORITY OF INDIA LIMITED
## BHILAI STEEL PLANT
## General Technical Specification

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>IS no.</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>c)</td>
<td>-do-</td>
<td>One 25mm nozzle <em>(Stainless Steel)</em></td>
<td>-do-</td>
</tr>
<tr>
<td>d)</td>
<td>-do-</td>
<td>One nozzle spanner <em>(Stainless Steel)</em></td>
<td>-do-</td>
</tr>
</tbody>
</table>

### B. YARD HYDRANT

1. IS:5290 Type-A (1993) Fire hydrant (landing valves) single outlet oblique type of 75mm flanged inlet, 63mm outlet with hand wheel, Instantaneous bronze female coupling at outlet and blank cap. *(Stainless Steel)* | -do- |

2. IS:6392 Table-18 (1971 R.A.1988) MS matching flange DN 80 (Slip-on type) with bolts, nuts & gaskets for the above hydrants | -do- |

3. Hose cabinet with glass front (suitable for outdoor installation, One number Hose box for each landing valve to keep 15 m long hoses (2 Nos.), branch pipe, nozzle and spanner) consisting of the following | -do- |

   a) IS:636 Type-B(1988) & IS:903 (1984 R.A.-1990) Reinforced rubberised fabric lined flexible canvas hose of 15m length having 63mm dia, each fitted (as per IS:1648 -1961) with instantaneous male Coupling at one end and female Coupling at the other end including intermediate coupling for joining 1x15m long hose. | -do- |

   b) IS:903 (1984 R.A.1990) One branch pipe *(Stainless Steel)* | -do- |

   c) -do- One 25mm nozzle *(Stainless Steel)* | -do- |

   d) -do- One nozzle spanner *(Stainless Steel)* | -do- |

The details and specification of pumps, valves, pipes, fitting, pipe supports and associated civil, structural, electrical, instrumentation, material handling, air-conditioning & ventilation etc. as specified above and as mentioned in other clauses of this specification are applicable for this system also.
### F. EQUIPMENT PREFERRED MAKE

List of Preferred Makes For Fire Protection System

<table>
<thead>
<tr>
<th>序号</th>
<th>设备类型</th>
<th>制造/供应商</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Steel pipes</td>
<td>SAIL, ITC, JINDAL, Ajanta, Maharashtra Seamless, Prakash Tubes Gujarat Steel tubes,</td>
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<td>ii. Steel pipes fittings</td>
<td>Tube Bends, Jindal, Ajanta Shivananda, EBY Industries.</td>
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<td></td>
<td>iii. Spray nozzles/Projectors</td>
<td>Laxmi sprinklers, Reliable, Avon, Mather and Platt, HD Fire.</td>
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<td>v. Outside coating&amp; Wrapping-for pipes</td>
<td>Llyods/STP</td>
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<td></td>
<td>vi. Quartzoid bulb detector</td>
<td>H.D. Fire Protect Co., Mather &amp; Platt, Any other TAC approved make</td>
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<td>vii. Diesel Engine</td>
<td>Kirloskar-Cummins, Crompton - Greaves, Ashok Leyland</td>
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<td>viii. Fire extinguishers</td>
<td>New Fire, VIPL, Zenith, ASCO Strumech, Peter Autokits, Bharat, Minimax, Safex, Safe Zone</td>
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<td>ix. Fixed fire protection system-</td>
<td>New Age, Agnice, Lloyds Insulation, Techno Fire Controls</td>
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ARCHITECTURE

(CHAPTER-11)
STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT

GENERAL SPECIFICATION
FOR
ARCHITECTURAL
(GS – 11)

MECON LIMITED
RANCHI – 834002

No. MEC/S/1901/11/38/0/00/00/F1889/R2

JULY, 2007
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ARCHITECTURAL WORKS

General Specifications for Architectural Works

1.0 FLOORING

1.1 TERRAZO TILES/CAST-IN-SITU

1.1.1. Tiles will generally be 250 x 250 x 20mm laid over concrete bedding to resulting an overall thickness of 40mm

1.1.2. 40mm thick cast in-situ mosaic flooring shall be used.

1.2 CERAMIC/VITRIFIED TILES

1.2.1 Ceramic tiles with matt finish will be used in toilets. The tiles will be 300 x 300 x 6.80mm (approx.) of approved shade brand and colour.

1.2.2 Vitrified ceramic tiles of approved size, shade and brand shall be used

1.3 ACID/ALKALI RESISTING TILES

1.3.1 Areas coming into contact with acid/alkali vapours or fumes will be given acid/alkali resistant tiles 20 mm thick, jointed with acid/alkali resistant cement mortar. Bedding will comprise of potassium silicate mortar conforming to IS:4832 (Part-1) and resin based mortar like epoxy for jointing. Total thickness of flooring will be 40mm.

1.4 PVC FLOOR FINISH

1.4.1 2mm thick antistatic PVC tiles as per IS:3462 and laid as per IS:5318 over concrete under bed of 38mm will be provided in all control room, electronic cubicle rooms, conference room, etc.

1.5 FINISH FOR STAIR CASES

1.5.1 Risers and treads of staircases will be provided with finish matching with the skirting/floor finish with 25mm nosing. Staircase wall will be given dado of same finish to a height of 2100mm

1.6 IRONITE/IPF FLOOR

1.6.1 Ironite flooring with metallic hardener/non metallic hardener of 40mm thickness shall be used.
1.6.2 40mm thick IPS flooring shall be used.

1.7 **STONE FLOOR**

1.7.1 20/25mm thick kota stone flooring shall be used.

1.7.2 18/20mm white marble flooring shall be used

1.8 **MISCELLANEOUS**

1.8.1 Angles 75 x 75 x 6mm (minimum) with lugs will be provided for edge protection of cutouts/openings in floor slabs, edge of drains covering gratings, edge of R.C.C. cable /pipe trenches of any other place where breakage of edges / corners is expected.

1.8.2 Architectural features with ceramic wall tiles cladding shall be used as per requirement.

1.8.3 False flooring with 8mm thick granite tiles topping to be used

1.8.4 False flooring with 2mm thick PVC tile topping to be used

2.0 **SKIRTING / DADO**

2.1 Minimum 100mm / 125mm skirting matching with floor finish will be provided in all areas unless specified otherwise elsewhere.

2.2 Toilets will be provided with dado up to the height of 2100mm from floor with colour / design glazed tiles of minimum 5mm thickness generally as per IS:777.

2.3 Areas coming in contact with acid / alkali spillage / fume, dado of acid /alkali resistant tiling will be provided to a height of 2100mm set in potassium silicate mortar and joints pointed with resin bounded mortar.

3.0 **PLASTERING**

3.1 External face of all walls will be provided minimum 20mm thick cement mortar plastering.

3.2 Internal face of all walls will be provided with minimum 15mm cement mortar plastering

3.3 Inside surfaces of walls will be provided with 2mm thick plaster of paris punning over the plastered surfaces in office areas, corridor, control room and all other
3.4 Ceiling of all buildings except over false ceilings will be given 6mm thick cement sand plaster 1:4.

4.0 PAINTING

4.1 Details furnished below are the minimum acceptable standard for painting

4.2 Exterior emulsion paint of approved brand and shade will be provided on external faces of walls, sunshades, etc.

4.3 Inside surfaces will be provided with Acrylic emulsion paint for Control Room, Control Equipment Rooms, all air conditioned areas and all other areas and above dado in toilets etc.

4.4 All plastered ceilings will be painted with Acrylic / synthetic distemper over a coat of cement primer.

4.5 Painting for structural steel will be as described in technical specifications.

4.6 Battery rooms / laboratories will be painted with acid/alkali resistant paint

i) All paints will be of approved brand and make as per the approval of owner.

ii) A minimum of two finishing coats of paint over a primer will be provided.

iii) All fire exits will be painted in Post Office red colour shade which will not be used anywhere except to indicate emergency or safety measure.

iv) All painting on masonry or concrete surfaces will preferably be applied by rollers.

v) Surface texture finish shall be used

5.0 ROOF DRAINAGE AND WATER PROOFING

5.1 The gradient will preferably provided by sloping the structural framing system itself. Gradient may also be provided using screed concrete of grade M20 using 12.5mm downgraded aggregate. But the average thickness of such screed concrete will be restricted to about 50mm. In the case of metal roofing system the roof slope will be 1 vertical:3 horizontal.
6.0 FALSE CEILING AND UNDER DECK INSULATION

6.1 Gyp board false ceiling system will consist of 600 x 600 x 12.5mm gypboard with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system will be provided with G.I. system as per manufacturer’s specification.

6.2 Suitable M.S. channel (minimum ISMC 100) grid will be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures. AC ducts etc.

6.3 A layout of the false ceiling system shall be prepared incorporating light fixtures, supply air diffuser, return air grills, fire detectors, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work will commence only after the approval of the layout.

6.4 Under deck insulation, wherever required, will be as detailed in the technical specifications.

7.0 DOOR, WINDOWS & PARTITION

7.1 All doors, will be of 35mm thick flush door, windows and ventilators will be of steel. View panels will be provided in doors wherever required. The fixtures and hard ware will be of best quality and will be provided as detailed in the technical specifications.

7.2 Wherever functionally required, rolling shutters with suitable operating arrangement manual / Electrical will be provided to facilitate smooth operations.

7.3 Fireproof doors will be provided at all fire exit points as per the recommendations of LPA. These doors will generally be as per IS:3614 (Part-I and Part-II). Fire rating of the doors will be as per LPA requirements. However minimum rating will be 2 hours. These doors will be double cover plated type with mineral wool insulation.

7.4 Aluminium doors & windows

7.4.1 Aluminium glazed glass door with floor spring and toughend shall be used.

7.4.2 Aluminium glazing with double layer heat insulated glass shall be used.

7.4.3 Aluminium partition with aluminium frame using toughend glass to be used.

7.4.4 Aluminium window with toughend glass to be used.
7.5 PVC Doors

7.5.1 PVC door with PVC frame work and hardware fitting shall be used.

7.6 Hardware fittings for doors and sindows:

Fittings for steel doors:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item</th>
<th>Nos. of Single leaf</th>
<th>Nos. for double leaf</th>
</tr>
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<tr>
<td>1.</td>
<td>MS Aldrop</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>MS Tower bolt for top</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Mortice lock</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>MSHinge</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>5.</td>
<td>MS Door handle (One on each face)</td>
<td>2</td>
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Fittings for flush door shutter:

<table>
<thead>
<tr>
<th>Sl. No.</th>
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<th>Nos. of Single leaf</th>
<th>Nos. for double leaf</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Towerbolt 300mm for top</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>Tower bolt 150mm for bottom</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Aldrop 300mm long with 16mm sliding bolt</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Door handles with continuous plate 150x38x12mm rod</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>Butt hinge (125 x 63x4mm) with cadmium plated MS screws</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>6.</td>
<td>Door stopper</td>
<td>1</td>
<td>2</td>
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<tr>
<td>7.</td>
<td>Rubber buffer</td>
<td>1</td>
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Note: Mortice lock and hydraulic door closer to be used in door.

8.0 GLAZING

8.1 All ventilators and windows on external face of all the buildings covered in the scope will be provided with plain glass of minimum 4mm thickness conforming to IS:5437.

8.2 Ground glass / frosted glass of minimum 4mm thickness will be used for all windows / ventilators in toilets.
8.3 Toughend glass shall be used in partition and glazing

9.0 WATER SUPPLY AND SANITATION

9.1 Polyethylene water storage tank conforming to IS:12701 will be used. The tank will be complete with all fittings including float valve, stop cock etc.

9.2 Galvanised iron pipe of medium class conforming to IS:1239 will be used for internal piping works for potable water supply. For concealed pipes the pipes will be of heavy class.

9.3 The toilet block will have the following minimum facilities calculated based on minimum 25 persons as per stipulations of National Building Code. The facilities will be suitably increased based on the stipulation of NBC for every increase of 25 users. Unless specified all the fittings will be of chromium plated brass. The toilet blocks will be provided with adequate capacity exhaust.

i) All the facilities such as WC, Urinals, wash basins etc. will be of approved colour

ii) WC (Indian type) Orissa pattern (580 x 440mm) as per IS:L2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type.

iii) WC western type 390mm high as per IS:2556 (Part-2) with toilet paper roll holder and all fittings including flushing system of appropriate capacity and type.

iv) Urinal with all fittings, marble partition and flushing system as per IS:2556 (Part-6, Sec.1)

v) Wash basin with all fittings as per IS:2556.

vi) Wall to wall bathroom mirror (5.5mm thick float glass) with bevelled edges including all fittings.

vii) Stainless steel towel rail (600 x 20mm)

viii) Stainless steel liquid soap holder cum dispenser.

ix) Installation of water cooler of adequate capacity

9.4 All plumbing, sanitary fittings, connections and service lines will be provided as per requirement. All service lines, water supply, plumbing lines and other utility lines will be concealed with in the brick / concrete work and removable wooden panels will be provided at intervals for access.

9.5 Sewerage system will be provided with adequate ventilation for the pipe work as well as manhole.
INFORMATION TECHNOLOGY

(CHAPTER-12)
GENERAL SPECIFICATION
FOR
INFORMATION TECHNOLOGY
(GS – 12)

MECON LIMITED
RANCHI – 834002

No. MEC/S/1901/11/38/00/00/F1889/R2

JULY, 2007
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01 LEVEL– II AUTOMATION

01.1 CONTROL PHILOSOPHY

State-of-the-art Level-II process control automation system shall be provided for various plant units of Bhilai Steel Plant (Purchaser). The Level-II automation system shall be interfaced with the level-III system under purchaser’s scope.

At Level-I is the basic automation and field devices, which measures the process parameters continuously. At Level-II are the process models which cyclically calculate the desired set points from the Level-I inputs, confirms and downloads them through PLC/DCS/Integrated Control System for optimum quality and productivity. Some shop supervisory functionalities such as material specification, plant practice data, tracking, scheduling etc are included under Level-II system. The level-II system shall be connected to the Level-III system and other relevant plant units. All these systems shall seamlessly integrate over the plant wide TCP/IP based Ethernet network with fiber optics backbone (under purchaser’s scope).

The applications shall be modular, multi layered and real-time systems with facilities for secured remote web based access.

01.2 GENERAL

01.2.1 The tenderer shall provide complete and State-of-the-art Level-II automation system for the plant. The new system shall incorporate the latest open system technology with TCP/IP network.

01.2.2 The tenderer shall satisfy themselves thoroughly regarding hardware, networking and software specified in the tender document and take full responsibility for suitability thereof of for output, reliable working as well as ease of operation and maintenance including replacement with minimum down time.

01.2.3 All equipment / systems shall be complete in all respects and any hardware, networking equipment and software not covered in the technical specification, but essential for proper design and operation, shall be deemed to be included in the scope of the tenderer.

01.2.4 All software shall be delivered in English language only.

01.2.5 Only licensed copies of operating system, system software, utility software, language compilers, database, development tool, application software including process model and/or any other software necessary for development of application software along with requisite number of user licenses shall be provided for each server.

01.2.6 Requisite number of licenses of operating system, utility software, front-end development tool and application software shall be provided for each client PC’s.

01.2.7 Model set-up (initialization ) data shall be provided.

01.3 SPECIFICATION OF EQUIPMENTS AND SOFTWARE

The general specification for equipments and software are given below:
01.3.1 Hardware

1. SERVER TYPE- I
   Servers excluding web server shall conform to the following minimum specification:
   - Main Memory – minimum 4 GB DDR SDRAM upgradeable to 32 GB
   - Minimum 146 GB x 4 hot pluggable SCSI 15000 rpm hard drive
   - RAID 0 +1 or RAID-6 features
   - External Hard Drive for Backup (Min 200GB) – 1 No.
   - DVD- Writer
   - DVD- ROM
   - DAT Drive 80 GB
   - 10/100/1000 MBPS Network adapter teaming (minimum two numbers)
   - 19” TFT LCD monitor with multimedia keyboard and optical mouse
   - Redundant hot swappable power supply. If a power supply unit fails, operation shall continue with the remaining power supply without any disruption.
   - Redundant fan
   - 4 high speed USB ports (2 in front), 2 serial ports, 1 parallel port, 1 PS/2 port, keyboard interface and console interface.
   - The main memory and hard disk shall have at least 50% of reserve capacity at full load. Additional main memory and hard disk shall be provided to meet the above criteria if required. However minimum main memory and hard disk shall be provided as specified in the technical specification.
   - CPU scaleable by 100 %. Enough Main Memory (RAM) with free slots to scale it up by 100 % by adding memory
   - Antivirus Software with minimum 3 years up gradation license.
   - Two fibre channel host bus adapter for connecting to SAN
   - 64 bit processors
   - Processor shall be minimum from following configuration
     - Two way Intel 64 bit Xeon dual core processors (minimum 3.2 GHz with 2x2 MB L2 cache and 1066 MHz FSB) or equivalent
     - Four way Itanium II 64 bit processor (minimum 1.6 Ghz with 4 MB L3 cache and 533 MHz FSB)
     - Two way 64 bit AMD Opteron dual core processors (minimum 2.8 GHz with 2x2 MB L2 cache)

2. SERVER TYPE- II
   Xeon based Web servers shall conform to the following minimum specification:
   - 64 bit Intel Xeon dual processor (min 3.0 GHz with 1 MB L2 cache and 800Mhz FSB) or equivalent AMD Opteron server
   - Main memory – minimum 2 GB expandable up to 16 GB
   - Minimum 146 GB x 2 SCSI 15000 rpm hard drive.
   - RAID 5 features
   - DAT drive of 80 GB
   - DVD- Writer
3. Storage Area Network (SAN)
Storage Area Network (SAN) system where ever required shall be as follows:
- Dual fiber channel RAID controller
- 146 GB x 6 (15000 rpm) fiber channel SCSI Hard disk drive (Hot Swap disk)
- RAID 0 +1 and RAID-6 controller
- Minimum 8 port storage area network switch
- Required software as applicable for storage area network such as SAN management software, data replication, volume and file management software.
- Redundant RAID controllers
- Redundant Hot pluggable power supply
- Redundant Hot pluggable Fan
- Facility for taking backup

The location and size of the plant server room shall be decided during detail engineering stage.

4. Client PCs:
The PC shall conform to the following minimum specifications:
- Pentium IV or equivalent with 3.0 GHz (min) cycle time with Hyper Threading Technology
- 1 GB main memory – DDR2 RAM
- 80 GB hard disk
- 1 No. 3.5" floppy drive
- 1 No. DVD-ROM/ CD R/W Combo Drive
- 19" TFT LCD colour monitor
- Multimedia keyboard
- Optical mouse
- 10/100 MBPS Ethernet Card
- 4 USB ports (with minimum 2 in front side), 2 Serial ports, 1 Parallel port, 1 PS/2 Port, keyboard interface, VGA interface
- Graphics accelerator card
- Windows XP professional with service pack 2 or latest with media CD
- Antivirus Software with minimum 3 years up gradation license.
5. **Laptop:**
   The laptop shall conform to the following minimum specifications:
   - Pentium IV mobile or equivalent with 1.5 GHz (min) cycle time
   - 512 MB main memory – DDR2 SDRAM
   - 80 GB hard disk
   - 1 No. CD R/W/ DVD-ROM Combo Drive
   - Integrated wireless LAN 802.11b/g
   - Multimedia keyboard
   - Optical mouse
   - 10/100/1000 MBPS Ethernet Card
   - 4 USB ports, 2 Serial ports, 1 Parallel port, 1 PS/2 Port, keyboard interface, VGA interface
   - Graphics accelerator card
   - Windows XP professional with service pack 2 or latest with media CD
   - Antivirus Software with minimum 3 years upgradation license.

6. **A3 coloured laser printers:**
   - A3 and A4 Coloured printing
   - 16 ppm, heavy duty
   - 1200 x 1200 dpi
   - Postscript and barcode capability
   - Network printing capabilities with hardware (network interface card)
   - Interface: Centronics and USB

7. **A3 Black and white laser printers:**
   - A3 and A4 printing
   - 21 ppm, heavy duty
   - 1200 x 1200 dpi
   - Postscript and barcode capability
   - Network printing capabilities with hardware (network interface card)
   - Interface: Centronics and USB

8. **A4 black and white laser printers:**
   - 14 ppm heavy duty
   - 1200 x 1200 dpi
   - A4 black and white printing
   - Postscript and barcode support
   - Interface: Centronics and USB

9. **A4 black and white combi laser printers:**
   - A4 printing
   - Min. 20 ppm
• 1200 x 1200 dpi
• Copying and scanning capabilities
• Fax functionality
• Network printing capabilities with hardware (network interface card)
• Interface: Centronics and USB

Industrial enclosures which shall maintain dust-free environment and temperature of 22°C +/- 2°C at an ambient temperature of 50°C shall be provided for housing all PCs not located in air-conditioned environment.

Power distribution boards, switches, emergency switches, and power cabling for supplying power to computer equipment shall be provided.

Location of server room, PCs/printer and other peripherals shall be decided at detail engineering stage.

Hardware shall be of latest prevailing version.

01.3.2 Network Configuration
1) The TCP/IP (with full quality of service -QoS features) gigabit Ethernet network shall be essential for the implementation of the process control system and interfacing with Level-III system of the purchaser. The gigabit plant LAN shall have multimedia capability with multiple concurrent video conferencing with panning and zooming. Necessary connectivity shall be provided for plant wide gigabit network (under purchaser’s scope). Communication link with redundancy shall be provided between Level-II and Level-I system. Necessary hardware, software and network equipments shall be provided for the same.

2) Methodology for assigning the actual IP address for equipments shall be finalized during the detail design stage.

3) Adequate number of switches with necessary fiber module will be available through plant wide gigabit network (under purchaser’s scope) in the server room of respective new shops(upcoming) to facilitate communication with other shops and the Level-III system(under purchaser’s scope). None of the switches/hubs of the plant wide network shall be used for connecting the servers/clients of the Level-II automation system. The necessary connectivity of new LAN of different new shops with plant wide network shall be provided by the Tenderer.

4) The network shall be designed to support multi-vendor communication based on international standards organization’s open system interconnection standard (OSI). It shall be easily expandable to keep pace with growing application requirements.
5) The LAN shall be based on 1000 Mbps (TCP/IP gigabit Ethernet) network with single mode fiber optic cable and Cat 6 UTP (unshielded twisted pair)/STP (shielded twisted pair) cable as the medium of communication. Cat 6 cable may be used inside the control rooms/buildings for short distances (limited to 90 meters) wherever required. Whereas, for the clients located outside the building premises or for longer distances FO cable shall be used to provide the connectivity.

6) The actual cable length of fiber optics cable and Cat 6 UTP/STP cable shall be calculated only at the detail engineering stage.

7) At each of the client location, the PCs shall be connected through Information Outlets. There shall be enough provision for additional clients in future. PCs and the network equipment shall be powered from 5/15 ampere UPS socket outlets with proper Earthing. The information outlets shall be connected to the network switch. Switches shall be connected point-to-point making a ring of redundancy. Network cable shall trace separate/ alternate routes for making ring of redundancy. 100% redundant Fiber module shall be provided in each switch. Number of switches shall be decided during detail engineering stage.

8) Clients and servers located at designated places shall be connected through a structured cabling of single mode fiber optic and Cat 6 UTP/STP to form a gigabit LAN. Servers shall be connected using 1000 Mbps network interface card port of server and 1000 TX port of switch in a structured fashion using information outlet. The FO cable shall be of minimum 6 core single mode with heavy duty PVC sheathing and shall be laid in cable tray/trenches/pipe away from High Tension lines running between the various designated buildings/control rooms.

9) Supplier shall provide spare racks for all the cable trays at all the places.

10) Indoor cabling between switch and PCs shall be of Cat 6 UTP/STP cable in PVC pipes in a structured fashion from information outlet to patch panel and from patch panel to switch in wall mounted racks. For shop floor overhead laying of Cat 6 UTP/STP cable medium duty GI conduit shall be used.

11) All pulpits, control rooms, shift rooms including maintenance post and designated rooms in administrative buildings shall have network connectivity.

12) The minimum specification of the Layer 2 switches shall be:
   - Modular and Scalable with full expansion capability managed L2 Switch
   - Configurable up to 8000 MAC addresses with Power over Ethernet
   - Switching Fabric >= 8 Gbps.
   - Forwarding rate >= 6 Mpps
   - Redundancy
• Redundant Power Supply
• Redundant Switching fabric

Protocols/Standards support:
• Ethernet IEEE 802.3, 10 Base T
• Fast Ethernet
• Gigabit Ethernet-(IEEE 803z, 802.3ab)
• 802.1 p/q - VLAN Tagging
• 802.3x - Flow Control
• Port Mirroring
• L2, access control filters.
• Rapid Spanning Tree Protocol (RSTP)(802.1w)/ equivalent
• Multiple Spanning Tree Protocol (MSTP)(802.1s )/ equivalent
• Bandwidth aggregation of up to 8 Gbps through Gigabit Ether Channel technology
• 802.1x - IBNS-Identity Based Networking Services
• Port Aggregation Protocol (PAgP )/ equivalent
• Link Aggregation Control Protocol (LACP )/ equivalent
• Unidirectional Link Detection Protocol (UDLD). )/ equivalent
• Up to 32 VLANs per switch
• 128 spanning-tree instances per switch. )/ equivalent
• Per-port broadcast, multicast, and unicast storm control
• IGMP (Internet Group management protocol)
• Multicast VLAN Registration/ equivalent

Network Management features:
• Web based
• Telnet and TFTP access
• RMON
• SNMP agent

Architecture Features:
• Layer 2 switching (managed)

Quality of Service (QoS)
• 802.1 p prioritization with minimum 4 priority queues
• Provision for IP telephony & VOIP support
• Differentiated services as defined in RFC 2474
• Traffic policing
• In-profile and out profile packet making
• Traffic shaping
• Integrated services for client and server applications as defined in RFC 1633
• RSVP signaling (RFC 2205)
• Guaranteed service(RFC 2212)
• Controlled Load service (RFC 2211)
• RAPI shared library for application
Expandability
- Minimum 4 slots shall be available for future expansion

All equipments shall support TCP/IP with full QoS features.

01.3.3 System Software

01.3.3.1 Operating system for server
Process control servers shall have operating system with real time features. All process control servers shall have preferably UNIX based O/S. However, Windows Server – 2003 or latest prevailing version can be considered in case application software package supplied by tenderer does not support UNIX based OS.

01.3.3.2 Utility Software:
- Language compilers like C/C++ for servers/clients for development of application software (wherever required).
- ORACLE 10g (or latest version) with RAC (real time clustering features) - Relational data base management system for data base server, process control server, standby server (where ever required)
- Web server software
- Front end development tools for GUI (preferably MS .NET, Visual Basic)
- Any special software /development tool necessary for development of application software including models, graphics for server/clients.
- Any special software /development tool necessary for development of web based applications.

01.3.4 Application Software - General

01.3.4.1 The general features of the application software are given below:-
- Variable names and all comments used in the application software shall be in English language only.
- The latest software shall provide easy to use user interface with multi windowing support.
- Application software shall have menu driven form/display.
- Uniform software design and programming standard shall be used for all automation system.
- Ease of software maintenance, so that parameters can be changed without changing the source code. No hard coding shall be allowed.
- Error logging system shall be provided in the application software
- The application system running on clients shall be developed under a common software platform, with multi-windowing capability and shall have following features:
  - Easy to use user interface
  - Display of real time process value
  - Process and equipment control parameters
01.3.4.2 Data Logging and Recording into History File (Logs and History)

The system shall perform data logging of process and set values. One-year data shall be kept in database. Other data shall be backed up for historical purposes. It shall be possible to retrieve the data as and when required. Actual duration of log shall be decided during engineering.

01.3.4.3 Trending / Debugging

- Graphical display of set points and process values.
- Graphical trends of process values.
- Historical graphical trends

01.3.4.4 Communication with Level-III system (Under purchaser’s scope)

Requisite data regarding production results, alarm logs, quality logs, delay logs, material usage information, maintenance details, any other necessary events & logs shall be transmitted to Level-III system. The details shall be worked out at requirement specification/ detail engineering stage. In order to prevent the loss of data in case of a link failure, Level-II automation system shall be capable of storing these logs for at least fifteen (15) days and shall retransmit the same to Level-III system after communication link resumes. Necessary interface to receive production plan and any other information from Level-III system shall be provided.

01.3.4.5 Production and Quality reporting system

- Recording of periodical production target
- Recording of production
- Generation of MIS reports
- Generation of periodical deviation report
- Generation of Test and Inspection reports

Necessary Internet connectivity will be provided through plant wide gigabit network (under purchaser’s scope) to achieve the secured web based access.

01.3.4.6 Alarm logging, Display and Print out

The computer shall monitor alarm conditions for the parameters monitored, display it on a PC, log it and generate printouts as and when required.
01.3.4.7 Operator Interface
Operator interface shall be provided for visualization and over-riding with appropriate security in following areas:-
- Control pulpits
- Computer room
- Laboratory
- Shift In-charge
- Managers

01.3.4.8 Clock Synchronization
Tenderer shall designate a time server which shall synchronize with specified clock source of existing plant wide network. All systems of the unit / package shall synchronize to this designated time server. Necessary hardware and software shall be provided for clock synchronization of all computers, network equipments and Level-I system. There should not be any data loss or application error during clock synchronization. The tenderer shall specify the clock synchronization interval.

In case of linkage failure with the specified clock source of existing plant wide network, tenderer shall provide clock synchronization between level-I and level-II system.

01.3.4.9 House Keeping
Software shall be provided to perform housekeeping services such as archiving taking backups / restoration of data from backup/archives etc.

Complete backup (including setup data, tuning data, etc.) shall be provided after the acceptance of hardware and software and tenderer shall restore the backup and run the server with restored copy.

Automatic deletion of temporary files (generated by application software) shall be provided.

The software offered shall fulfill all the requirements as specified in technical specification. Any additional software, utilities and protocols for meeting the project requirement and system performance shall be provided at no extra cost.

The tenderer shall fulfill all requirements of the application software as per technical specification (partially described here above) and process & production requirements.

01.3.5 Operating Environment
All hardware and networking equipment shall operate under the following environment:
- Temperature up to maximum 50°C Celsius.
- Relative humidity up to 90%.
- Voltage range: 230 V (+/-) 10% or as prevailing in purchaser's premises.
- Frequency range: 50Hz (+/-) 0.1% or as prevailing in purchaser's premises.
- Earth to neutral shall be 5 V
  All equipment shall run continuously.

01.3.6 **Communication Cable:**
Communication cable for connecting server, PCs, printers (local as well as remote), PLC/DCS/ICS, any other instrumentation system shall be provided by the supplier.

**Specification of Fibre Optic Cable (SMF Outdoor)**
- Single Mode fiber 9µm/125µm
- Attenuation@1310nm <= 0.35dB/km
  @1550nm <= 0.25dB/km

01.3.7 **Cable laying - as required for**
- Communication cables
- Power Cables in the computer premises for individual equipment

01.3.7.1 **Cable laying method:**
**UTP/STP cable laying & termination:**
1) For indoor surface cable laying, medium duty PVC channel/pipe (ISI) of adequate size shall be used.
2) For shop floor overhead cable laying, medium duty GI conduits shall be used. The conduits shall be laid along the structural columns, girders, trusses etc. and shall be clamped properly at every meter of the pipe run.
3) The cables shall be dressed and terminated in accordance with the recommendations made in the relevant TIA/EIA standard document, manufacturer's recommendation and/or best practices.
4) Cable shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack.
5) Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed clearly without removing the bundle support ties. Cables shall be properly marked and distinctively coloured for ease of identification.
6) An axial spacing of 150 mm (minimum) shall be maintained between power and network cable.
7) Cables shall not be attached to ceiling grid or lighting support wires.
8) Holes in walls, ceiling etc. shall be made and plugged to their original finish after drawing the cable.
9) Adequate heat insulation shall be provided for cables passing through hot zone.

01.3.7.2 **Fibre optic cable laying & termination**
1) GI pipes shall be used for exposed FO cable laying in plant shops.
2) GI pipes shall be firmly supported in position by means of heavy gauges saddles either screwed in concrete/brick walls using suitable plugs or screwed to MS brackets/cleats welded on to building structures. The spacing between the supports for both horizontal and vertical runs shall not be more than one meter for straight runs. At bends or termination to junction/pull boxes, the nearest support shall be within 300 mm from such fittings.

3) Exposed pipes shall run parallel or perpendicular to column/building lines to match the existing architectural arrangement.

4) The fibre stack shall be neatly coiled within the fibre termination panel. No slack loops shall be allowed external to the fibre panels.

5) Each cable shall be individually attached to the respective termination panel by mechanical means.

6) All network cabling shall be structured, tested and certified.

7) Each fibre cable shall be stripped upon entering the termination panel and individual fibre routed in the termination panel.

8) Each cable shall be clearly labeled at the entrance to the termination point. Cables labeled within the bundled shall not be acceptable. Cables shall be properly marked and distinctively coloured for ease of identification. GI pipes housing the FO cables shall be heat insulated in areas subjected to heat.

9) Dust caps shall be provided on the connectors and couplings.

10) GI pipe shall be used for routing cables embedded through concrete foundation/floors/walls generally in plant buildings. GI pipes shall be medium gauge, hot dip galvanized electric resistance welded, screw type conforming to IS: 1239(part-I) latest revision. All pipe fittings shall conform to IS: 1239(part-II) latest revision.

11) Underground cable shall be laid generally about 1.0 meter below the finished ground level and shall be provided with at least 75 mm sand cushioning both at top and bottom with brick top cover and sand filling for mechanical protection. Where power and network cables run side by side, the axial spacing shall not be less than 300 mm. Identification flags/ cable marker for underground cable laying shall be provided. Inspection pit at appropriate distances shall be provided for under ground cables.

12) The excavation of trenches shall be done straight as far as possible. Width of the trench shall be in accordance with the number of cables to be laid but in any case shall not be less than 300 mm.

13) After cable laying, the trenches shall be back filled in layers with each layer being well rammed, consolidated and sufficient allowance made for settlement. In case of road crossing, the damage to the road done shall be made good to its original finish. For crossing of road, railway tracks etc the cable shall be laid in GI pipe.

14) In each cable run, some extra length shall be kept at suitable points to enable one or two straight through joints in future. When a number of cables are laid together, the extra cable length shall be adjusted to stagger the straight through joints.

15) Adequate heat insulation shall be provided for cables passing through hot zone.

01.3.8 Power Supply System

The power supply system shall comprise of following:
- Power Cables, Power distribution Board – as required.
- Circuit Breakers etc. - as required
- Local UPS - if required such as Switches, etc.

01.3.9 Earthing system
Earthing of the computer system (server and PCs) and associated peripherals at the server room, control rooms, different locations (to be finalized at detail engineering stage) including civil work (earthing pit) shall be provided as per relevant IS.

01.3.10 Furniture
Suitable furniture for the computer equipment’s shall be supplied. The furniture of reputed make shall include tables, racks and chairs (at least one table & chair for every server & client) etc. for equipment and operators, storage cupboard, book shelves, shoe racks, maintenance workbench, etc. in sufficient numbers. Necessary storage cupboard shall be provided in server rooms for storing manuals etc. Aesthetically designed consoles shall be provided for servers in server rooms, in place of tables. Servers and switches shall be housed in suitable enclosures.

1.3.11 Spares & Consumables

1.3.11.1 Commissioning spares
All commissioning spares along with list shall be provided as per requirement.

1.3.11.2 Operating Spares
Two years operating spares list shall be provided.

1.3.11.3 Consumables
The Tenderer shall provide all consumables as required for installation, successful commissioning and demonstration of plant Performance Guarantee parameters at their own cost. The consumables list along with quantity shall be provided.

1.3.12 Minor Civil Works – as required

1.3.13 Tools and Tackles

- Test equipments, tools, etc. for all relevant hardware and/or software systems.
- Test and maintenance equipment shall be provided for maintenance and troubleshooting of FO cables.

01.4 Training
The following training shall be imparted for Level-II automation system:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating System, utility software, debuggers, web server</td>
</tr>
<tr>
<td>Sl.No.</td>
<td>Item</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Oracle Database</td>
</tr>
<tr>
<td>3</td>
<td>Development tool</td>
</tr>
<tr>
<td>4</td>
<td>Communication Software</td>
</tr>
</tbody>
</table>

All the Training to be conducted by OEM or its authorized training partner at a fully equipped training center with facilities where extensive hands-on exercises can be performed with system similar to one under supply. Curriculum, duration and number of participants for each program shall be finalized in consultation with purchaser at a later stage.

### 01.5 OTHER OBLIGATION OF TENDERER

01.5.1 Requisite diagnostic programs/tools, test equipment and all documentation for hardware and software shall be provided.

01.5.2 Preparation and submission of all relevant drawings and documents for information/approval.

01.5.3 Software maintenance and updates as required for successful operation of the systems.

01.5.4 Purchaser will have an option of purchasing the latest hardware/software at the time of approval of system configuration during detail engineering stage. It shall be obligatory for the tenderer to bring to the notice of the purchaser, the latest information on product available along with their recommendations.

01.5.5 The system shall be upgraded in case it does not meet the capability requirements to meet the performance guarantee of total system without any extra cost.

01.5.6 The tenderer shall be responsible in case any hardware or software supplied by them infringes patents. The tenderer shall indemnify the purchaser against any damage or penalties on this account.

01.5.7 All tools and testing equipment required for installation and commissioning of the complete system shall be supplied.

01.5.8 Application software shall have built-in features of model tuning to take care of local conditions at site. It shall allow further model tuning with on line production data after successful commissioning.

01.5.9 Test certificates and details of test procedures shall be furnished.

01.5.10 The functional responsibility, of the project includes collection and measurement of all data required for various functions.

01.5.11 The switches/gateways/bridges for 100% availability for communication with Level-I automation system shall be provided by the tenderer.

01.5.12 Software implementation methodology:

  The following methodology shall be adopted for the implementation of the application software at basic and detail engineering stage:

  01.5.12.1 Submit documents and information at both basic and detail engineering stage.

  01.5.12.2 Prepare requirement specification and submit to the purchaser for approval.

  01.5.12.3 Discussions with the purchaser and/or his designated consultant.

  01.5.12.4 Incorporate comments, prepare revised requirement specification and submit for approval.
01.5.12.5 Obtain approval of revised requirement specification.
01.5.12.6 Prepare System design document, Submit system design for approval.
01.5.12.7 Obtain approval of system design.
01.5.12.8 Program coding, testing and installation.
01.5.12.9 Hot test including model tuning.

01.5.12 All drawings, designs, configurations, software, models etc. listed in TS and GTS are indicative and minimum only. Tenderer may suggest a better and more comprehensive solution.

01.6 WORK PLAN AND METHODOLOGY
The tenderer shall furnish the work plan methodology from the start of award of the contract to the completion of the contract, for approval by purchaser/designated representative.

01.7 ACCEPTANCE TEST PROCEDURE
Provisions shall be made for off-line testing of Level-II systems prior to actual deployment.

All tests on software, hardware, network, communication, etc. shall be carried on the basis of a pre-agreed protocol clearly listing out steps involved in testing with its responsibility and minimum expected results as per specifications, engineering and other documents.

01.7.1 Computer hardware and Network
1) The acceptance test shall be carried out by the tenderer in the presence of the purchaser / representative of purchaser. The complete hardware shall be visually inspected to ensure the completeness of the scope of supply along with agreed specifications including erection and its fitness for operation. In order to qualify for acceptance, each of the computer system and all individual equipments including network equipments shall operate up to 24 hours a day for seven (7) consecutive days at an over all average up-time efficiency of 98.5%.
2) Besides the above acceptance clause for individual equipments, the integrated operation of the full system with entire network shall be demonstrated up to 24 hours a day for seven (7) consecutive days at an overall average uptime efficiency of 98.5%. The network shall be tested for attenuation and signal loss.
3) Up-time efficiency is defined as productive and error free use of equipment. Any unutilized time during the test shall also qualify as uptime provided there are no hardware and software malfunctions.
   Uptime efficiency shall be computed as under:
   \[
   \left( \frac{\text{Uptime} \times 100}{\text{Total available time}} \right)
   \]
4) The tenderer’s personnel shall successfully demonstrate network operations as per mutually agreed procedure in the presence of authorized representative(s) of the Purchaser during the testing period to ensure that the network operations confirm to the specified performance.
In case the required uptime efficiency is not obtained as mentioned above, the acceptance will be repeated for same time period.
5) A total period of 30 days shall be allowed for completion of acceptance test for hardware and network after start of acceptance test.

01.7.2 System Software and Application software:
Hot test shall be carried out for fifteen (15) continuous working days of error free operation. In case of detection of bug / errors, the test shall be restarted from zero date (beginning) after fixing of the bug. In case any change in application software is required to meet the process and production requirements, the tenderer shall do the same without any extra cost. Being turnkey supplier, the tenderer shall ensure that all requirements for the tests are met before the start of acceptance test.

01.7.2.1 Hot test:
1) Hot test shall be carried out after one month of stable operation of the plant and shall be scheduled with PAC/FAC of plant.
2) During the hot test period, the application software /Level-II automation system shall be tested with all live data including communication with Level-I (from PLC/DCS/ICS/any other special controller). All the modules shall be tested and demonstrated for error-free performance as per the specification and approved documents. The functions as specified in the contract and the approved requirement book shall be demonstrated.
3) Error free functioning of operating system/ system software/ database/ utility software/ communication software/ any other special software supplied by the tenderer shall also be demonstrated for consecutive period of 15 day (24 hours a day) during the hot test period.
4) Model shall be tuned as per the site conditions before the start of hot test. The test should be completed within one month of the start of the test.
5) Acceptance certificate shall be provided by Purchaser on successful completion of hot test.

01.8 Defect Liability (Warranty)
Tenderer shall provide defect liability services for hardware, system software and application software in accordance with the clause number 30 of standard bidding documents of SAIL (project directorate).

Tuning/customization/modification/bug removal of application software shall be carried out as per plant actual operating practices during defect liability services period.

The period of defect liability services shall be governed by clause number 30 of standard bidding documents of SAIL (project directorate).

Post defect liability services shall be provided on mutually agreed terms and conditions (if required)
## 01.9 DOCUMENTATION

### 01.9.1 Documentation (Type of media and no. of copies)

Documentation shall be as follows:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>ITEM</th>
<th>No of Hard copies</th>
<th>No of Copies on CD-ROM/DVD-ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating system, System Software and utilities software, database, communication software.</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Hardware manuals</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Language Compilers</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Development tool</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Any Special Software supplied by the tenderer</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Requirement Specification</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>System Design Document</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>User Manual of Application software including models</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Maintenance Manual for troubleshooting of all application software including process model, system software, configuration, hardware, network, etc. should be provided clearly spelling out possible causes, checks and measures for corrective action.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Additional set of all training manuals for purchaser’s archive and not for participants</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>All other additional documents/ manuals as mentioned below under 01.9.2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>Licenses</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

### 01.9.2 Documentation (List)

The following shall be submitted for approval. All documentation shall be in English language.
01.9.2.1 At Basic engineering stage:
- Layout drawing showing location of all computer equipment, furniture.
- Single line diagram for power supply to computer system / equipment.
- Computer Room Layout Drawing
- Network diagram (for equipment and cabling)
- Equipment earthing/grounding diagrams.
- Control system interface signal list.
- Computer system equipment installation layout.
- List of hardware along with the following:
  - Trade catalogs with MTBF and MTTR of each equipment and the computer systems as a whole.
  - Thermal load, running and startup power requirement, environmental condition (both storage and running) including electromagnetic interference and vibrations in the building for each equipment.
  - Dimensions, weight, area, point and distributed load on floor, etc. as applicable.
- Detailed requirement specification containing:
  - List of hardware and system software.
  - Detailed description of each module, operator dialogues, displays, reports, etc.
  - Period of storage for all logs, displays and report shall be indicated.
  - Detailed procedures for operation in semi-automatic mode.
- The following shall also be complied by the tenderer as part of application software and shall be submitted during basic engineering:
  - Details of quality assurance measures for various phases of project implementation for approval.
  - Overall data flow diagram.

01.9.2.2 At Detail engineering stage:
- System configuration diagram integrated with Level-I automation system (including Network Schematic diagram).
- Cable routing.
- Final Single line diagram for power supply to computer system / other computer and network equipments.
- Final control system interface signal list.
- Final computer system equipment installation layout
- User specific application source code (including forms & reports) surrounding the process model/kernel. The information regarding maintenance shall be provided. Interfacing details of sub systems to models shall be provided.
- Source code for process models (optional)
- System design document containing:
  - Database structures for application software
  - Form/report layout
  - Details features of model tuning to suit local conditions
  - Metallurgical background of process models
The following hardware and networking manuals shall be furnished over and above the manuals mentioned above:
- Installation manual providing step-by-step procedure for installation of the whole system.
- Hardware and networking installation manuals for individual equipments.
- Hardware and networking maintenance manuals for individual equipments.
- Site preparation documents/drawings providing details of space, flooring, roofing, temperature, humidity, storage, power requirement.
- Operator's manual providing details of the procedure for operating the equipment including safety procedures.
- Training manuals in hard copies for maintenance personnel, supported CD ROM's/DVD ROM's etc.
- Detailed procedure to recover in case of failure of the CPU, hard disk drives, communication links between the servers, their clients, etc., shall be furnished.
- Logical screen shots for hardware/software configuration.

The following documentation/manuals shall be furnished for system software and application software:
- User manuals for operating system, utilities, language compilers, RDBMS, etc.
- Reference manual for operating system, utilities, language compilers, RDBMS etc.
- Application software maintenance manual.
- Operator manuals for application software. The manual shall describe all the tasks that an operator needs to undertake while using the Level-II/III system.
- Model tuning manuals including tools & procedures.
- As built system design document updated as per implementation at site.

01.10 INFORMATION /DATA /DRAWINGS TO BE FURNISHED BY THE TENDERER ALONGWITH THE TENDER

- Configuration diagram of the Level-II automation system integrated with Level-I automation system.
- Reference list of projects where similar system including hardware, system software and application software has been implemented. The list shall include details such as name of the client, address, contact numbers, cost and duration of the project, system configuration, year of implementation, Level-II functions being performed, benefits achieved, etc.
- List of deviations from the technical specification, if any, with reasons thereof.
- The tenderer shall inform the purchaser about the latest versions of hardware and software available before finalization of order. Only latest versions shall be supplied.
PREFERRED MAKES

(CHAPTER-13)
GENERAL SPECIFICATION
FOR
PREFERRED MAKES
(GS – 13)
## CONTENTS

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<td>PREAMBLE</td>
</tr>
<tr>
<td>02</td>
<td>FLUID SYSTEM</td>
</tr>
<tr>
<td>03</td>
<td>VENTILATION, AIR CONDITIONING AND AIR POLLUTION CONTROL EQUIPMENT</td>
</tr>
<tr>
<td>04</td>
<td>HANDLING &amp; HOISTING EQUIPMENT</td>
</tr>
<tr>
<td>05</td>
<td>REPAIR &amp; MAINTENANCE FACILITIES</td>
</tr>
<tr>
<td>06</td>
<td>ELECTRICAL</td>
</tr>
<tr>
<td>07</td>
<td>INSTRUMENTATION</td>
</tr>
<tr>
<td>08</td>
<td>FIRE PROTECTION SYSTEM</td>
</tr>
<tr>
<td>09</td>
<td>BOF GCP EQUIPMENT</td>
</tr>
<tr>
<td>10</td>
<td>INFORMATION SYSTEM</td>
</tr>
<tr>
<td>11</td>
<td>FLUID SYSTEMS &amp; PIPING ENGG (LUBRICATION &amp; HYDRAULICS)</td>
</tr>
</tbody>
</table>

PAGE NO. 1, 2, 9, 11, 16, 17, 25, 30, 30, 32, 34
01. **PREAMBLE**

This document “PREFERRED MAKES OF EQUIPMENT AND SUPPLIES” is a part of the tender specification for various packages of BHILAI STEEL PLANT.

The makes of various equipment and supplies in respect of imported/indigenous equipment/components/materials are listed out in this document. It is essential that the equipment/component/materials to be supplied from imported/indigenous sources by the Tenderer will be of any one of the makes listed against that particular equipment/component/material in this document.

In case the Tenderer/ Contractor intends to substitute any particular make of equipment / components/ materials by a make other than that listed in this document, the Tenderer shall clearly bring out the same in his tender along with justification and indicate the alternative makes offered by him. It will be prerogative of the Purchaser to accept or reject the alternative makes so offered.
## FLUID SYSTEM

### 01.01 Water Supply Facilities

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Horizontal Centrifugal Pumps</td>
<td>Kirloskar Brothers, KSB, Beacon Weir, Khimline, Jyoti, Sintech, Ghaziabad.</td>
</tr>
<tr>
<td>2</td>
<td>Vertical Turbine Pumps</td>
<td>Kirloskar Brothers, Voltas, WPIL, Jyoti,</td>
</tr>
<tr>
<td>3</td>
<td>Vertical Wet Pit Type Pumps</td>
<td>SU Motors, Kishore Pumps, Kirloskar Brothers, KSB.</td>
</tr>
<tr>
<td>4</td>
<td>Submersible Pumps</td>
<td>KSB, SU Motors, Kirloskar Brothers, Kishore Pumps, Darling, Beacon Weir.</td>
</tr>
<tr>
<td>5</td>
<td>Slurry Pump</td>
<td>Akay, Sam Engg., MBE, KBL, KSB Pumps, WARMAN.</td>
</tr>
<tr>
<td>6</td>
<td>Dosing Pump</td>
<td>Shapo Tools, Asia LMI (Madras), Positive Metering Pumps, Toshniwal, Milton Roy</td>
</tr>
<tr>
<td>7</td>
<td>Cooling Towers</td>
<td>PCTPL, Shri Ram Tower Tech, Gammon, Himgiri, Southern Cooling Tower, BDT, GEA</td>
</tr>
<tr>
<td>8</td>
<td>Pressure Filters</td>
<td>Thermax, Ion-Exchange, Resin India, Driplex, Doshion, VA Tech Wabag, UEM,</td>
</tr>
<tr>
<td>9</td>
<td>Sluice Gates</td>
<td>Jash Engineering, IVPL</td>
</tr>
<tr>
<td>10</td>
<td>Travelling Water Screen</td>
<td>Macmet, Triveni, Otokin, Mecgale (Nagpur), General Mechanical</td>
</tr>
<tr>
<td>11</td>
<td>Sludge Scraper</td>
<td>Triveni, Neo – Parisrutan, Mata India, Geomiller</td>
</tr>
<tr>
<td>12</td>
<td>Fire Hydrants</td>
<td>New Age Industries, Steelage Industries, ASCO, Strumech, Vijay Fire, Zenith</td>
</tr>
<tr>
<td>13</td>
<td>Basket Strainers</td>
<td>Filtration Engrs, J.N Marshall, Masturlal Fabrication, ARF Engg, Purolator Filters, ABB, Filters Mfd India</td>
</tr>
<tr>
<td>14</td>
<td>Duplex Strainers</td>
<td>Filtration Engrs., Otokin, Superflo</td>
</tr>
<tr>
<td>15</td>
<td>Rubber Dismantling Joints</td>
<td>BDX, CORI Engineers, D.Wren,</td>
</tr>
<tr>
<td>16</td>
<td>Diesel Engine</td>
<td>Cummins/Ashok Layland/Ruston</td>
</tr>
<tr>
<td>19</td>
<td>Effluent Treatment Plant</td>
<td>UEM India, VA Tech, GEA Energy Systems, Triveni,</td>
</tr>
<tr>
<td>20</td>
<td>Drinking water Treatment Plant</td>
<td>UEM India, VA Tech, GEA Energy Systems, Driplex Water Engg, Triveni.</td>
</tr>
<tr>
<td>21</td>
<td>Basalt Liners</td>
<td>DEMECH, Vidut Green Bank, Enviro Abrasian, Garden</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Item Description</td>
<td>Manufacturers</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>22</td>
<td>Oil Skimmer</td>
<td>JVM Engg.</td>
</tr>
<tr>
<td>23</td>
<td>Plate Heat Exchangers</td>
<td>Alfalaval, GEA Ecoflex, IDMC</td>
</tr>
<tr>
<td>24</td>
<td>Surge Tanks</td>
<td>Anup Engg., Zenith Erectors, Haldia., Perfect Engg., Sakhthi Hitech</td>
</tr>
<tr>
<td>25</td>
<td>C.I. Valves (gate, globe, NRV)</td>
<td>Kirloskar Brothers, Steam &amp; Mining, IVPL, AV Valves, <strong>Shiv Durga</strong>, BDK, Fouress.</td>
</tr>
<tr>
<td>26</td>
<td>CS Valves (gate, NRV)</td>
<td>Audco, Fouress, <strong>Sakhi</strong>, KSB, Steam &amp; Mining, BDK, Kirloskar, Virgo</td>
</tr>
<tr>
<td>27</td>
<td>Plug Valves</td>
<td>Audco- <strong>L&amp;T</strong>, <strong>Vass Ind.</strong>, Xomox, Virgo, BDK, <strong>Steam &amp; Mining</strong></td>
</tr>
<tr>
<td>28</td>
<td>Ball Valves</td>
<td>Audco, KSB, <strong>AL Saunders</strong>, Xomox, Virgo, BDK, Virgo ,</td>
</tr>
<tr>
<td>29</td>
<td>GM Valves</td>
<td>Leader, Steam &amp; Mining, NECO, Upadhyay Valves, Kalpana Valves</td>
</tr>
<tr>
<td>30</td>
<td>Butterfly Valves (Manually &amp; electrically operated)</td>
<td>L&amp;T, Fouress, Kirloskar Brothers, IVPL, <strong>VIRGO</strong>, <strong>AL Saunders</strong>, Steam &amp; Mining, Keystone, BDK, XOMOX.</td>
</tr>
<tr>
<td>31</td>
<td>Diaphragm Valves</td>
<td><strong>AL Saunders</strong>, Fluid System, BDK, Steam &amp; Mining.</td>
</tr>
<tr>
<td>32</td>
<td>Float Valve</td>
<td>Leader, IVPL, IM Engineers, Steam &amp; Mining.</td>
</tr>
<tr>
<td>33</td>
<td>Control Valve</td>
<td>BHEL, L&amp;T, Fouress, IL, MIL Controls, NECO Scharbet, Darling</td>
</tr>
<tr>
<td>34</td>
<td>Solenoid Valve</td>
<td>Rotex, <strong>Sicmag, Scharder</strong>, NECO INDFOS, <strong>Eastern Pneumatic</strong>, Bluestar, AVCON, ASCO, Mercury</td>
</tr>
<tr>
<td>35</td>
<td>Air Release Valve</td>
<td>Shiva Durga, IVPL, IM Engineers, Steam &amp; Mining, Schroder Duncum, Fluid Line Valves.</td>
</tr>
<tr>
<td>36</td>
<td>Pressure Reducing Valve</td>
<td>JNM, Fouress, Bestobell, IL, Mazda, Nirmal Ind., Forbes Marshall</td>
</tr>
<tr>
<td>37</td>
<td>Strainer/Filter</td>
<td>Otokiln, Superflo, Triveni Plenty, Filter Mfg. Ind., Purolator, Filteration Engineers</td>
</tr>
<tr>
<td>38</td>
<td>Electric Actuators</td>
<td>Beacon Rotork, Auma, Marsh Engineers, Keystone, Limitorque, Antrieb, IL, Palghat</td>
</tr>
<tr>
<td>40</td>
<td>Hoses</td>
<td>Aeroflox/Markwel/Senior Flexonics, Inalsa, Teksons</td>
</tr>
<tr>
<td>41</td>
<td>Pipes a) MS/GI</td>
<td>SAIL/TATA/Jindal/Zenith/Man/SAW/Surindra/Welspun/Prakesh</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>b) DI</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electro Steel Casting</td>
</tr>
<tr>
<td>42</td>
<td>RCC Pipes &amp; Fittings</td>
<td><strong>SUR Industrial Pipes</strong>, Hind Ceramics, Indian Hume Pipes, Daya Cuncrching.</td>
</tr>
<tr>
<td>43</td>
<td>HDPE Pipes &amp;</td>
<td><strong>EMCO</strong>, KWH Heliplastic Polyolefins, Oriplast</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Item Description</td>
<td>Manufacturers</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Fittings</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>PVC Pipes &amp; Fittings</td>
<td>Oriplast, Finolex, Bharat Pipe &amp; Fittings, Supreme Industries.</td>
</tr>
<tr>
<td>45</td>
<td>SS Pipes / SS Fittings</td>
<td>Heavy Metal Tubes, Nobel Tubes, Rajendra Mech. Ind., Vitrag, SAIL, Poonam Enterprises, N.L.Hazra, M.S.Fittings</td>
</tr>
<tr>
<td>46</td>
<td>Seamless, Stainless Steel Pipes/Tubes</td>
<td>Choksy Tubes, MJ Patel, Nagardas Kanji, Poonam Enterprises, Sandulk Asia, Noble Tubes, Allied Steel, SAIL, Maharasta Seamless (P) Ltd.</td>
</tr>
<tr>
<td>47</td>
<td>Fittings for the above Pipes/Tubes</td>
<td>EBY Ind., High-Tech, Hydro technic, Hydro-Air Engg., Project Toolings, Shivananda, M.J.Patel, Nobles Tubes, Allied Steel, Poonam Enterprises, N.L.Hazra, M.S.Fittings</td>
</tr>
<tr>
<td>48</td>
<td>Wrapping &amp; Coating for pipes</td>
<td>Rustech Products, HOTACO, IWL, M P Tar Products</td>
</tr>
<tr>
<td>49</td>
<td>Chemical Dosing System</td>
<td>Hindustan Dorr Oliver, Tellabs Chemicals, Chembondaundrytreat ltd., NALCO</td>
</tr>
</tbody>
</table>

**01.02 Valves For Fuel Gas, Steam, Nitrogen, LPG & Compressed Air Facilities**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.I. Valves for Fuel Gas &amp; Compressed Air (gate, globe, NRV)</td>
<td>Kirloskar Brothers, GM Dalui, Steam &amp; Mining, H.Sarker, IVPL, AV Valves, Leader, Associated tooling, BDK, Kalpana Valves</td>
</tr>
<tr>
<td>CS, FS, SS Valves for Steam, Feed Water, &amp; LPG (Gate, Globe, NRV)</td>
<td>L&amp;T (Audco Div), Fouress, BHEL, KSB, GM Dalui, Leader, BDK, NECO, Associated Tooling, Hawa Egr., Vass Ind, Advance Valves, Kalpana Valves</td>
</tr>
<tr>
<td>CI, CS, SS &amp; FS Plug Valves</td>
<td>Vass Ind., Xomox, Virgo, BDK, Leader, Steam and Mining, GM Dalui, H.Sarkar, Audco</td>
</tr>
<tr>
<td>Ball Valves</td>
<td>Audco, Vass Ind, KSB, BDK, Microfinish, Niton, AL Saunders, Xomox, Virgo, United Engineers, Steam &amp; Mining, Hi-Tech B.Valves</td>
</tr>
<tr>
<td>GM Valves</td>
<td>Bombay Metals, GM Dalui, Leader, NECO, Kalpana Valves</td>
</tr>
</tbody>
</table>

Diaphragm Valves: AL Saunders, Fluid System, Leader, BDK, Xomox, Steam & Mining

Pressure Control Valve/Pressure Reducing Valve: JNM, Fouress, Bestobell, IL, Mazda, Nirmal Ind., Vanaz, Kosan Metal, Vass Ind., RK Control, Fluid Line, Forbes Marshal, Leader.

Large Diameter Goggle Valve: Audco, Fouress, Cimmco, L&T

Fabricated Gate Valves: Fouress, Cimmco, BECO, Beekay, L&T, Kalpana Valves


02.03 Miscellaneous Gas Facility & Compressed Air Equipment

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Acetylene &amp; LPG Manifolds</td>
<td>Kamrup Industrial Gases, INOX, Titan Engg., BOC, Ramba Hydrogen, Asiatic Oxygen</td>
</tr>
<tr>
<td>Centrifugal Gas Booster</td>
<td>Andrew Yule, TLT, James Howden (U.K), Donkin (U.K), Hibhen</td>
</tr>
<tr>
<td>Twin Lobe Type Booster</td>
<td>Skoda, CKD Kompressors, MD Pneumatics, Demag Delavl, Bryan Donkin Sulzer, Oil &amp; Gas Plant Engg., (Tuthill), Kay International</td>
</tr>
</tbody>
</table>
**Gas/Air Compressors:**  Ingersoll Rand, Atlas Copco, KG Khosla, Kirloskar Pneumatic, Chicago Pneumatic, Mannesman Demag, Eliat, Cooper, Sulzor, Corken (USA)

**Hoses:**  Flexican, Gaytri Industrial Corpns., Inalsa, Teksons, Sudeep Industries, Markwell

**Valves for Oxygen Services:**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Non-Ferrous:</td>
<td></td>
</tr>
<tr>
<td>For Isolation</td>
<td>Bestobell (UK), ETH IRELAND (France), RT Orseal (UK), Trufllo (Belgium), Worcestor Controls (UK),</td>
</tr>
<tr>
<td>Quick Sheet-off Valve</td>
<td>Bestobell (UK), ETH IRELAND (France), RT Orseal (UK), Trufllo (Belgium), Worcestor Controls (UK), Moorco, SEBIM</td>
</tr>
<tr>
<td>Pressure Control Valve (PCV) &amp; Flow Control Valve (FCV)</td>
<td>SEVERN (UK), NELES SECK GLOKON (UK), IL (Palghat)</td>
</tr>
<tr>
<td>Solenoid Valve</td>
<td>AVCON, SEITZ, ROTEX, ASCO</td>
</tr>
<tr>
<td>Safety Relief Valve (SRV)</td>
<td>KUNKLE (USA), KEYSTONE (USA), BROADY (UK), MOORCO, SEBIM, IL (Palghat)</td>
</tr>
<tr>
<td>Pressure Regulators (Self regulating with pressure gauge) for Oxygen</td>
<td>ESAB, BOC, Speciality Gases, Kamrup Industrial Gases, Venaz Engineers, Nirmal Ind.</td>
</tr>
</tbody>
</table>

**POWER & ENERGY**
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Drying Unit</td>
<td>Chemech, Cleanair, Delair, Indcon, Mellcon, Mirch Mirex, Gaseonergy System Pune.</td>
</tr>
<tr>
<td>Condensate Pumps</td>
<td>KSB, BHEL, Kirloskar Brothers, Mather &amp; Platt, Khimline, Sigma</td>
</tr>
<tr>
<td>Ejector</td>
<td>BHEL, Weigand, Newfield, Mazda</td>
</tr>
<tr>
<td>Trap &amp; Strainer for Compressed Air &amp; Steam</td>
<td>Uniklinger, ESCO, JNM, Dryton Greaves, Forbes Marshall, Hawa Engrs., Mazda</td>
</tr>
<tr>
<td>Actuators</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>AUMA India, Beacon Rotork Controls, Continental Profiles, Emtork Actuators, Limitorque</td>
</tr>
<tr>
<td>Pneumatic</td>
<td>Marsh Engg., Keystone, IL, Massoneilian, EL-O-MATIC, Virgo, AL Sauder, L&amp;T, Flocan</td>
</tr>
<tr>
<td>Heat Exchanger (Shell &amp; Tube Type)</td>
<td>BHPV, Kaveri, Texmaco, Thermax, Babcock &amp; Wicox, Parkair Engg., Rhine, Universal Heat Exchanger, Godrej, L&amp;T, GEI Godavari, Patel Air Temp., Hindustan Radiaton</td>
</tr>
<tr>
<td>Control Valves</td>
<td>Blue Star, Fouress Engg., IL, JNM, Mazda, Forbes Marshall</td>
</tr>
<tr>
<td>Suction Filters</td>
<td>FMI, KAAF, L&amp;T, Flakt, Autokiln Filter, GEC Alsthom, Filtration Engr., ARF Engg., ABB, Dyna Filter, Purolator Filters, GM Dalui</td>
</tr>
</tbody>
</table>
### 02.04 Pipes & Fittings for Water Supply, Gas Facilities, Steam and Compressed Air Facilities.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seamless, Stainless Steel Pipes/Tubes</td>
<td>Amardeep Steel, Choksy Tubes, MJ Patel, Nagardas Kanji, Poonam Enterprises, Sandulk Asia, MEC Tubes, Nagardas &amp; Kusai, Noble Tubes, Allied Steel, Kamlesh Tube, Menilal &amp; Bro, Uday Tubes, SAIL, Maharastra Seamless (P) Ltd, Imperial Steel, Soor Neogi Koumar.</td>
</tr>
<tr>
<td>Fittings for the above Pipes/Tubes</td>
<td>EBY Ind., High-Tech, Hydro technic, Hydro-Air Engg., Project Toolings, Shivananda, M.J.Patel, Nagardas &amp; Kusai, MEC Tubes, Nobles Tubes, Amardeep Steel, Allied Steel, Kamlesh Tube, Menilal &amp; Bros, Poonam Enterprises, N.L.Hazra, M.S.Fittings</td>
</tr>
<tr>
<td>RCC Pipes &amp; Fittings</td>
<td>SUR Industrial Pipes, Hind Ceramics, Indian Hume Pipes, Daya Cuncrching.</td>
</tr>
<tr>
<td>HDPE Pipes &amp; Fittings</td>
<td>EMCO, KWH Heliplastic Polyolefins, Oriplast</td>
</tr>
<tr>
<td>PVC Pipes &amp; Fittings</td>
<td>Oriplast, Finolex, Bharat Pipe &amp; Fittings, Supreme Industries.</td>
</tr>
</tbody>
</table>
### VENTILATION, AIR CONDITIONING & AIR POLLUTION CONTROL EQUIPMENT

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifugal fans for Ventilation</td>
<td>C.Doctor, EFE, AEROVENT, Flow Link, Andrew Yule, RIECO, ISEL, BATLIBOI, Flaktwood, REITZ, ACCEL, Dustven, INDFAN</td>
</tr>
<tr>
<td>Centrifugal fans for Dedusting</td>
<td>BHEL, TLT, C.Doctor, Andrew Yule, RIECO, Batliboi, F.Harley, Flaktwood, REITZ, DUSTVEN, ISEL, INDFAN</td>
</tr>
<tr>
<td>Tube axial fans / Propeller Fans</td>
<td>C.Doctor, EFE, Flow Link, ALMONARD, ACCEL, KHAITAN, AEROVENT, ISEL, INDFAN</td>
</tr>
<tr>
<td>Panel filter for air</td>
<td>FMI, Clean Filter Industries, EFE, ACCEL, FILTRONIC, FLOWLINK, CADILLAC, C. DOCTOR</td>
</tr>
<tr>
<td>Air washer</td>
<td>C.Doctor, EFE, FLOW LINK, FHARLEY, ALSTOM, Dustven, BATLIBOI, FMI</td>
</tr>
<tr>
<td>Man coolers</td>
<td>C.Doctor, Ventura, LM ENGINEERS, KHAITAN, ALMONARD, DUSTVEN, FLOWLINK</td>
</tr>
<tr>
<td>Roof exhauster</td>
<td>C.Doctor, EFE, ACCEL, ALMONARD, FLOWLINK, INDFAN, AEROVENT</td>
</tr>
<tr>
<td>Window air conditioners</td>
<td>Fedders Lloyd, VOLTAS, Blue Star, ARCTIC, Carrier Aircon, LG, Samsung, HITACHI</td>
</tr>
<tr>
<td>Packaged air conditioners</td>
<td>VOLTAS, Blue Star, KIRLOSKAR, ACCEL, BATLIBOI, EMERSON, FEDDERS LLOYDS, ROOS TEMPKOOL, ROOTS COOLING</td>
</tr>
<tr>
<td>Item Description</td>
<td>Manufacturers</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Packaged chillers</td>
<td>VOLTAS, Blue Star, ALSTOM, Batliboi, ACCEL, FEDDERS LLOYD, KIRLOSKAR, PNEUMATIC</td>
</tr>
<tr>
<td>Air handling units</td>
<td>VOLTAS, BLUE STAR, ALSTOM, BATLIBOI, PATELS AIR TEMP, ROOTS COOLING</td>
</tr>
<tr>
<td>Cooling towers</td>
<td>PAHARPUR, MIHIR, ADVANCE, GAMMON INDIA, Southern Cooling Towers Ltd., SHRIRAM TOWER TECH.</td>
</tr>
<tr>
<td>Refrigerant compressors</td>
<td>VOLTAS, SHRIRAM, ACCEL, BLUE STAR, Atlas Copco, Kirloskar, HITACHI</td>
</tr>
<tr>
<td>Cyclones</td>
<td>THERMAX, RIECO, ALSTOM, C.DOCTOR, F.HARLEY, Dustven, EFE</td>
</tr>
<tr>
<td>Multicyclones</td>
<td>THERMAX, ALSTOM, C. DOCTOR, BATLIBOI, RIECO, F.HARLEY, EFE</td>
</tr>
<tr>
<td>Bag filters (Cap – 10,000 m³/h to 80,000 m³/h)</td>
<td>THERMAX, ALSTOM, ANDREW YULE, RIECO, C.DOCTOR, F.HARLEY, Dustven, BATLIBOI, FMI</td>
</tr>
<tr>
<td>Bag filters (Cap – Above 80,000 m³/h)</td>
<td>ALSTOM, RIECO, THERMAX, VAI, Dustven, BATLIBOI</td>
</tr>
<tr>
<td>Wet scrubbers</td>
<td>ALSTOM, THERMAX, BATLIBOI, RIECO, C.DOCTOR, F.HARLEY, EFE, SOIL &amp; ENVIRO SYSTEM</td>
</tr>
<tr>
<td>Venturi scrubbers</td>
<td>BATLIBOI, THERMAX, RIECO, ALSTOM, Dustven</td>
</tr>
<tr>
<td>Electrostatic precipitators</td>
<td>ANDREW YULE, THERMAX, BHEL, VOLTAS, ABB, VAI</td>
</tr>
<tr>
<td>Insulation</td>
<td>TWIGA, LLOYS, BAKELITE HYLAM, MALANPUR ENTECH</td>
</tr>
<tr>
<td>Valves for air conditioning</td>
<td>DANFOSS, HONEYWELL, BLUE STAR</td>
</tr>
<tr>
<td>Vibration isolators</td>
<td>DUNLOP, EMERALD</td>
</tr>
<tr>
<td>Centrifugal horizontal pumps</td>
<td>KSB, BEACON WEIR, VOLTAS, KIRLOSKAR</td>
</tr>
<tr>
<td>Horizontal split casing pumps</td>
<td>VOLTAS, BEACON WEIR, KSB, KIRLOSKAR</td>
</tr>
</tbody>
</table>
## 04. HANDLING & HOISTING EQUIPMENT & COMPONENTS

### 04.01 Equipment

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>EOT Crane (Up to 10T capacity)</td>
<td>Armsel, Avon, FAFECO, Mukand, WMI, Anupam, Shivpra, Tubrofurguson</td>
</tr>
<tr>
<td>EOT Crane (Up to 50 T capacity)</td>
<td>HEC, Jessop, Mukand, Hyderabad Ind. Ltd., WMI, FAFECO, Unique, Anupam</td>
</tr>
<tr>
<td>EOT Crane (Above 50 T capacity)</td>
<td>Jessops, HEC, Mukand, FAFECO, Unique, WMI</td>
</tr>
<tr>
<td>Underslung Cranes (Upto 5t only)</td>
<td>Armsel, Brady &amp; Morris, Shivpra</td>
</tr>
<tr>
<td>Electric Hoists</td>
<td>Armsel, Shivpra, WH Brady, Brady &amp; Morris, Grip Engrs., Hi-tech, Century Crane</td>
</tr>
<tr>
<td>Transfer Cars</td>
<td>HEC, L&amp;T, Hyderabad Ind., Mukand, Eqipt Engrs, ELECON, TRF</td>
</tr>
<tr>
<td>Chain Pulley Blocks &amp; hand operated travelling cranes.</td>
<td>Armsel, Century Cranes, Brady &amp; Morris, Light Lift Ind., Hi-tech, MR Engg. Lifting Equipment</td>
</tr>
<tr>
<td>Shunting Winch</td>
<td>Beekay, HEC, Armsel, Century Cranes, Nirmal Equipments, Mining &amp; MH Equipment, Cyclo transmission</td>
</tr>
<tr>
<td>Jib Crane</td>
<td>Brady &amp; Morris, Century Cranes, Hi-tech, Grip Engrs., Elite, Light Lifting, Armsel</td>
</tr>
<tr>
<td>Crawler Mounted Mobile Crane</td>
<td>TIL, Hyderabad Industries, TATA-P&amp;H</td>
</tr>
<tr>
<td>Excavator/ Shovel</td>
<td>TIL, HEC, Hyderabad Industries, BEML</td>
</tr>
<tr>
<td>Elevator/Lift</td>
<td>OTIS, OMEGA, Kone, ECE</td>
</tr>
</tbody>
</table>
### Mechanical Components/ Equipment

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hooks</td>
<td>Herman Mohta, Free Trading Corporation, Steel Forgings &amp; Engg.,</td>
</tr>
<tr>
<td>Flexible / Geared coupling</td>
<td>Hiclliff, Concord, Wellman, GBM, Alliance, New Allenbery Works, Elecon,</td>
</tr>
<tr>
<td>Wire rope</td>
<td>Bharat Wire Rope, Orion Ropes, Usha Martin</td>
</tr>
<tr>
<td>Bearings for Cranes</td>
<td>SKF, FAG</td>
</tr>
<tr>
<td>Bearings for other equipment</td>
<td>SKF, FAG, Tata Timken, Asian Bearings, NRB, MBM</td>
</tr>
<tr>
<td>Oil Seals</td>
<td>Vaco Oil Seals, Rubber Equipment &amp; Engg. Sealjet India (Pune), Sealpack, Champion Seals</td>
</tr>
<tr>
<td>Lubrication Fittings</td>
<td>Lubcon, AFMC, Prakash, Lincoln</td>
</tr>
<tr>
<td>Lubricating Systems</td>
<td>AFMC, Prakash, Grindwell Norton, Lincoln Helios</td>
</tr>
<tr>
<td>Gear box</td>
<td>New Allenburry, Greaves Cotton, ELECON, Shanti Gears, Flender, AR Engg, Kirloskar, I.C.</td>
</tr>
<tr>
<td>Hydraulic Systems</td>
<td>Vickers Sperry, Yuken, Manesmann, Rexroth, Hugglands Denison-Parker</td>
</tr>
<tr>
<td>Hydraulic Coupling</td>
<td>Fluidomat, Ghatge Patil, VOITH, Prembrill</td>
</tr>
<tr>
<td>Centrifugal blowers</td>
<td>REITZ, Flaht Wood, James Howden (UK)</td>
</tr>
<tr>
<td>Burners</td>
<td>Stein Heurtey, Techint, LOI, Weswan North American, Eclipse, Hotwork</td>
</tr>
<tr>
<td>Recuperators</td>
<td>Eastern Equipment, GEFFI (Germany), SAFMAT (France), North American Minnt. Co. Thermal Transfer Corporation (USA)</td>
</tr>
</tbody>
</table>
### Item Description

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Pressure Vane/Piston Pump</td>
<td>Vickers, Yuker, Rexroth, Hugglands, Denison</td>
</tr>
<tr>
<td>Crusher</td>
<td>Sayaji, HEC, McNally Bharat, TRF, ELECON</td>
</tr>
<tr>
<td>DCEM Brake</td>
<td>Electromag, BCH, Industries Syndicate, Storm Kraft, Speed-O-Control</td>
</tr>
<tr>
<td>Track type Limit Switch</td>
<td>Electromag, BCH, Speed-O-Control, Jayshree, EP&amp;C, Bengal Technocrats</td>
</tr>
<tr>
<td>Thruster Brake</td>
<td>Electromag, BCH, Speed-o-Control, Elite</td>
</tr>
<tr>
<td>Belt changing Device</td>
<td>Nilos, Shawalmex</td>
</tr>
<tr>
<td>Conveyor Belting</td>
<td>Northland Rubber, Phoenix-Yule, Oriental Rubber</td>
</tr>
<tr>
<td>Vibrating Screen</td>
<td>IC, TRF, ELECON, McNally Bharat, L &amp; T, HEC, Orien, Electromag, Hyderabad Industries</td>
</tr>
<tr>
<td>Vibratory Feeder</td>
<td>Electromag, IC, TRF, Orien Engineers, ELECON, McNally Bharat</td>
</tr>
<tr>
<td>Magnetic Separators</td>
<td>Electromag, WMI, Magnet Corporation, Electromagnetic Ind., Ericz, Sartorius, Hans Bockels, Krupp Forder, Technick, L &amp; T</td>
</tr>
<tr>
<td>Pneumatic Actuators</td>
<td>Prepec, Technomech, Nucon Industries, OSCAR Equipt, Veljan Hydair.</td>
</tr>
<tr>
<td>Electro Mechanical Actuators</td>
<td>PREPEC, Technomech, Pebco</td>
</tr>
<tr>
<td>Item Description</td>
<td>Manufacturers</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Rubber liner</td>
<td>TEGA, Kaveri</td>
</tr>
<tr>
<td>Polymer liner</td>
<td>TEGA, Kaveri</td>
</tr>
<tr>
<td>Polyethelene liner</td>
<td>Kaveri, Tega</td>
</tr>
<tr>
<td>Polyurethane liner</td>
<td>Kaveri, Tega</td>
</tr>
<tr>
<td>Cast Basalt liner</td>
<td>DECCAN, Enviro Abrasion</td>
</tr>
<tr>
<td>Belt Scraper/ Belt Cleaner</td>
<td>Hosch Equipment, Vinar IDC, Kaveri Macmet, Hindustan Udyog Ltd., Karam Chand Thapper, Cobit Engg, Elecon, TRF, Promac, BMH Concire</td>
</tr>
<tr>
<td>Belt Switches</td>
<td>Jayshree, PROTO CONTROL, EPC</td>
</tr>
<tr>
<td>Bin Vibrator</td>
<td>Electromag, Electromagnetic Industries, IC</td>
</tr>
<tr>
<td>Samplers</td>
<td>Prisector (UK), Ramsay Engg (USA), Eastmn Crusher, Advanced system sampling (P) Ltd.</td>
</tr>
<tr>
<td>Belt Vulcanisers</td>
<td>Shaw Almex, Nilos India, SV Dattar</td>
</tr>
<tr>
<td>Sector Gates, Diverter Gates, Rack and Pinion Gates etc.</td>
<td>Vinar, IDC, Macmet, TRF, Precision Processing, Moktali, Holtzman, Mining &amp; Material, Chennai Radha,</td>
</tr>
<tr>
<td>Flexowel Conveyors</td>
<td>METSO, Flexowel</td>
</tr>
<tr>
<td>Drag Chain Conveyors</td>
<td>Moktali Engrs., TRF, Equipt Engrs, Redler India, Enviro Abrasion, Karam Chand Thapar,</td>
</tr>
<tr>
<td>Item Description</td>
<td>Manufacturers</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Bucket Elevator</td>
<td>Moktali, Golden Electrical, Hindustan Udyog, Vinar, Cobit, Shree Conveyor, IDC, Orien, Macmet, Elecon, TRF</td>
</tr>
<tr>
<td>Belt Feeder</td>
<td>Vinar, IDC, HEC, Orien, Macmet, Elecon, TRF, Cobit</td>
</tr>
<tr>
<td>Reclaimer</td>
<td>Metso, L&amp;T, Elecon, TRF, HEC</td>
</tr>
<tr>
<td>Stacker</td>
<td>Metso, L&amp;T, Elecon, TRF, HEC</td>
</tr>
<tr>
<td>Stacker – Cum-Reclaimer</td>
<td>Metso, L&amp;T, Elecon, TRF, HEC</td>
</tr>
<tr>
<td>Wagon Tippler</td>
<td>L&amp;T, HEC, Elecon, TRF, Metso</td>
</tr>
<tr>
<td>Wagon Loader</td>
<td>L&amp;T, HEC, Elecon, TRF, Metso</td>
</tr>
<tr>
<td>Belt Weigh Feeders &amp; Weigh Hopper</td>
<td>Kistler – Morse, Sartorius Mechatronics, Transweigh, Avery, Jenson Nicholson</td>
</tr>
<tr>
<td>Belt Weigh Scale</td>
<td>Kistler-Morse, Transweigh, Avery, Sartorius Mechatronics, Jenson Nicholson</td>
</tr>
<tr>
<td>Conveyor belt pulleys</td>
<td>Elecon, TRF, McNally Bharat, Macmet, HEC</td>
</tr>
<tr>
<td>Conveyor Idlers</td>
<td>Elecon, TRF, McNally Bharat, Kali, Hindustan Udyog Ltd., Macmet</td>
</tr>
<tr>
<td>Pneumatic Handling Equipment</td>
<td>TTG, Scorpio</td>
</tr>
<tr>
<td>Front – end – loader</td>
<td>TIL, Hyderabad Industries Ltd.,</td>
</tr>
<tr>
<td>Fork-lift-truck</td>
<td>Godrej, Voltas, TIL</td>
</tr>
</tbody>
</table>
## REPAIR & MAINTENANCE FACILITIES

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre Lathe</td>
<td>HMT, Mysore Kirloskar, HEC</td>
</tr>
<tr>
<td>Universal Milling m/c</td>
<td>HMT, BFW, Batliboi</td>
</tr>
<tr>
<td>Shaper</td>
<td>PAL, P&amp;B, Loyal</td>
</tr>
<tr>
<td>Radial Drilling m/c</td>
<td>HMT, Batliboi, Kerry Jost, HEC</td>
</tr>
<tr>
<td>Horizontal Boring m/c</td>
<td>HMT, HEC, PAL</td>
</tr>
<tr>
<td>Submerged Arc Welding Set</td>
<td>Advani, ESAB, ADOR, Mogora, COSMIC</td>
</tr>
<tr>
<td>Welding Rectifier</td>
<td>Advani, ESAB, ADOR, Mogora, COSMIC</td>
</tr>
<tr>
<td>Welding Transformer</td>
<td>Advani, ESAB, MEMCO</td>
</tr>
<tr>
<td>Universal Tool and Cutter Grinding m/c</td>
<td>HMT, Praga, Batliboi</td>
</tr>
<tr>
<td>Hydraulic Press</td>
<td>BEMCO, P&amp;B, Centerprise</td>
</tr>
<tr>
<td>Cast Iron Plate</td>
<td>Jash, Madras Gauge, P&amp;B</td>
</tr>
<tr>
<td>Power Hacksaw</td>
<td>ITL, P&amp;B, EIFCO</td>
</tr>
<tr>
<td>Column Drilling m/c</td>
<td>HMT, Thakoor, Kerry Jost, EIFCO, Batliboi</td>
</tr>
<tr>
<td>Bench Drilling m/c</td>
<td>Accuax, EIFCO, P&amp;B, Thakoor</td>
</tr>
<tr>
<td>Double-ended Pedestal Grinder</td>
<td>Grind Tools, GECO, AMC, P&amp;B</td>
</tr>
<tr>
<td>Cylindrical Grinder</td>
<td>HMT, Mysore Kirloskar, ELP</td>
</tr>
<tr>
<td>Tools &amp; Tackles</td>
<td>P&amp;B, Mekaster, Centerprise, Ally</td>
</tr>
<tr>
<td>Measuring Tools and Gauges</td>
<td>P&amp;B, Bombay Tools</td>
</tr>
<tr>
<td>Garage Equipment</td>
<td>ELGI, USHA, WAP, P&amp;B</td>
</tr>
<tr>
<td>Oiling &amp; Greasing</td>
<td>ELGI, P&amp;B</td>
</tr>
</tbody>
</table>
06. **ELECTRICAL**

The list of acceptable makes for various electrical and automation equipment is given below.

### A) POWER DISTRIBUTION EQUIPMENT

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>EQUIPMENT</th>
<th>PREFERRED MAKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TRANSFORMERS</td>
<td>ABB / AREVA / CGL / BHEL / BHARAT BIJLEE / VOLT AMP / KIRLOSKAR / INTRA VIDYUT /</td>
</tr>
<tr>
<td></td>
<td>a) DISTRIBUTION TRANSFORMER (OIL TYPE) (11 or 6.6/0.433 KV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) DRY TYPE TRANSFORMER</td>
<td>INTRA VIDYUT / VOLTAMP / KEC</td>
</tr>
<tr>
<td>2.</td>
<td>11kV / 6.6kV ISOLATOR</td>
<td>A BOND STRAND / S&amp;S, MADRAS / HIVEML / SIEMENS / DREISCHER-PANICKER.</td>
</tr>
<tr>
<td>3.</td>
<td>415V SWITCHBOARD</td>
<td>SIEMENS / L&amp;T / GE POWER / SCHNEIDER</td>
</tr>
<tr>
<td>4.</td>
<td>LT BUSDUCT</td>
<td>STARDRIVE / C&amp;S / PCE / ECC / BRIGHT ENGINEERS / VIDHYUT CONTROL</td>
</tr>
<tr>
<td>5.</td>
<td>BATTERY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) NICKEL - CADMIUM</td>
<td>AMCO / HBL NIFE</td>
</tr>
<tr>
<td></td>
<td>b) VALVE REGULATED LEAD ACID MAINTENANCE FREE BATTERY (VRLA)</td>
<td>HBL NIFE / AMARARAJA / EXIDE</td>
</tr>
<tr>
<td></td>
<td>c) BATTERY (PLANTE)</td>
<td>HBL NIFE / AMARARAJA / EXIDE</td>
</tr>
<tr>
<td>6.</td>
<td>BATTERY CHARGER/ DCDB</td>
<td>CHHABI / HBL NIFE / CALDYNE / AMARA RAJA / KIRLOSKAR</td>
</tr>
<tr>
<td>7.</td>
<td>PROTECTIVE RELAYS</td>
<td>AREVA / ABB / SIEMENS / ER</td>
</tr>
<tr>
<td>8.</td>
<td>AUXILIARY RELAYS</td>
<td>ABB / ER / SIEMENS / AREVA</td>
</tr>
<tr>
<td>9.</td>
<td>HEAT SHRINKABLE CABLE JOINTING KITS/ STRAIGHT THROUGH JOINTS (H.T)</td>
<td>RAYCHEM / DENSON / M-SEAL</td>
</tr>
<tr>
<td>10.</td>
<td>METER (ANALOGUE TYPE)</td>
<td>IMP / AE / MECO / SECURE METERS / CONZERV / L&amp;T / RISHAV</td>
</tr>
<tr>
<td>11.</td>
<td>CURRENT TRANSFORMERS</td>
<td>ABB / SILKANS / INSTRANS / PRAGATI / IMP / AE / KAPPA / PRAYOG / SIEMENS / L&amp;T</td>
</tr>
<tr>
<td>12.</td>
<td>POTENTIAL TRANSFORMER</td>
<td>ABB / BHEL / SILKANS / PRAGATI / IMP / KAPPA / PRAYOG / SIEMENS / ABB / INDOCOIL / PRECISION</td>
</tr>
</tbody>
</table>
### General Technical Specification

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**BHEL**

**Preferred Makes**

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<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>EQUIPMENT</th>
<th>PREFERRED MAKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>11KV/ 6.6KV CABLES</td>
<td>ASIAN CABLES (RPG) / CCI / UNIVERSAL / NICCO / POLYCAB / HAVELLS</td>
</tr>
<tr>
<td>14.</td>
<td>DIGITAL TYPE MULTIFUNCTION METER</td>
<td>CONSERVE / L&amp;T / SECURE / ER / RISHAV</td>
</tr>
</tbody>
</table>

---

**B ) LT PANELS, DRIVES, AUTOMATION & CONTROL ACCESSORIES.**

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>SUB GROUP</th>
<th>MAKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MCC (NON DRAW OUT)</td>
<td>SCHNEIDER / L&amp;T / SIEMENS / GEPOWER</td>
</tr>
<tr>
<td>2.</td>
<td>POWER DISTRIBUTION BOARD (PDB)</td>
<td>HINDUSTAN CONTROL / VENUS / SIEMENS / ABB / L&amp;T / GEPC / HAVELLS</td>
</tr>
<tr>
<td>3.</td>
<td>CONTROL DESK &amp; POST</td>
<td>HINDUSTAN CONTROL / POWER &amp; PROTECTION / ECC / VENUS / BCH / HAVELLS / GEMCO</td>
</tr>
<tr>
<td>4.</td>
<td>LOCAL CONTROL STATION (LCS)</td>
<td>HINDUSTAN CONTROL / POWER &amp; PROTECTION / ECC / VENUS / BCH / HAVELLS / GEMCO</td>
</tr>
<tr>
<td>5.</td>
<td>LIGHTING DISTRIBUTION BOARD MLDB, SLDB</td>
<td>HINDUSTAN CONTROL / POWER &amp; PROTECTION / ECC / VENUS / GEPC / BCH</td>
</tr>
<tr>
<td>6.</td>
<td>VVVF AC DRIVE</td>
<td>ABB / ROCKWELL AUTOMATION / SIEMENS / VACON / SCHNEIDER / L&amp;T</td>
</tr>
<tr>
<td>7.</td>
<td>SOFT STARTER</td>
<td>ROCKWELL AUTOMATION / ABB / SCHNEIDER / SIEMENS</td>
</tr>
<tr>
<td>8.</td>
<td>PROGRAMMABLE LOGIC CONTROLLER (PLC)</td>
<td>ABB (800 XA) / GE-FANUC (PAC Rx7i) / ROCKWELL AUTOMATION (CONTROLLOGIX) / SIEMENS (S7 SERIES)</td>
</tr>
<tr>
<td>9.</td>
<td>UNINTERRUPTED POWER SUPPLY (UPS)</td>
<td>TATA LIBERT (EMERSON) / GE / FUJI / DB ELECTRONICS</td>
</tr>
<tr>
<td>10.</td>
<td>LT AC MOTOR (SQ. CAGE)</td>
<td>ABB / BHARAT BIJLEE / CGL / KIRLOSKAR ELECTRIC ALSTOM / SIEMENS</td>
</tr>
<tr>
<td>11.</td>
<td>LT AC MOTORS (CRANE DUTY)</td>
<td>ALSTOM / KEC / CGL / SIEMENS</td>
</tr>
<tr>
<td>12.</td>
<td>HT AC MOTOR</td>
<td>BHEL / ABB / CGL / SIEMENS / KIRLOSKAR ELECTRIC / ALSTOM / WEG / GE</td>
</tr>
<tr>
<td>13.</td>
<td>LT AC GEARED</td>
<td>KIRLOSKAR ELECTRIC / POWERBUILD / NEW ALLEN</td>
</tr>
<tr>
<td>SL.NO.</td>
<td>SUB GROUP</td>
<td>MAKES</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>14.</td>
<td>FLAME PROOF LT SQUIRREL CAGE AC MOTOR</td>
<td>ALSTOM / BHARAT BIJLE / ABB / CGL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KIRLOSKAR ELECTRIC / SIEMENS</td>
</tr>
<tr>
<td>15.</td>
<td>SLIPRING MOTOR (OTHER THAN CRANE DUTY)</td>
<td>CGL / ALSTOM / SIEMENS / KIRLOSKAR ELECT CO.</td>
</tr>
<tr>
<td>16.</td>
<td>LT AC VVVF MOTORS FOR ROLLER TABLE APPLICATION</td>
<td>SIEMENS / ABB / KIRLOSKAR ELECT CO. / ALSTOM /</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CGL</td>
</tr>
<tr>
<td>17.</td>
<td>STALL TORQUE MOTOR</td>
<td>DEMAG</td>
</tr>
<tr>
<td>18.</td>
<td>ACTUATOR</td>
<td>AUMA / ROTORK / LIMITORQUE</td>
</tr>
<tr>
<td>19.</td>
<td>MOTOR PROTECTION CIRCUIT BREAKER (MPCB)</td>
<td>SCHNEIDER / ABB / L&amp;T / GEPOWER / SIEMENS</td>
</tr>
<tr>
<td>20.</td>
<td>MOULDED CASE CIRCUIT BREAKERS (MCCB)</td>
<td>SIEMENS / ABB / L&amp;T / GEPOWER / SCHNEIDER</td>
</tr>
<tr>
<td>21.</td>
<td>MINIATURE CIRCUIT BREAKER (MCB)</td>
<td>HAVELLS / MDS LEGRAND / SCHNEIDER / STANDARD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>/ GEPOWER / HAGAR (L &amp; T) / ABB / SIEMENS</td>
</tr>
<tr>
<td>22.</td>
<td>EARTH LEAKAE CIRCUIT BREAKER.(ELCB)</td>
<td>HAVELLS / MDS LEGRAND / SCHNEIDER / STANDARD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>/ GEPOWER / HAGAR (L &amp; T) / ABB / SIEMENS</td>
</tr>
<tr>
<td>23.</td>
<td>HRC FUSES</td>
<td>L&amp;T / SIEMENS / BUSMAN / GEPOWER / INDO-ASIAN</td>
</tr>
<tr>
<td>24.</td>
<td>VACUUM CONTACTOR (LT)</td>
<td>SIEMENS / L&amp;T / ABB / SCHNIEDER</td>
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<tr>
<td>25.</td>
<td>AC POWER CONTACTORS</td>
<td>ABB / L&amp;T / SCHNEIDER / SIEMENS / GE POWER /</td>
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<tr>
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<td>BCH</td>
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<td>26.</td>
<td>CRANE DUTY POWER CONTACTORS</td>
<td>ABB / SCHNEIDER / L&amp;T / SIEMENS / GEPOWER</td>
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<tr>
<td>27.</td>
<td>THERMAL OVER LOAD RELAY</td>
<td>ABB / C&amp;S / BCH / L&amp;T / SCHNEIDER/ GEPOWER /</td>
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<td>SIEMENS</td>
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<td>28.</td>
<td>ELECTRONIC THERMAL OVERLOAD RELAY</td>
<td>FANOX / SAMWHA / MOELLER / LG / SPECHER &amp; SCHUH</td>
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<td>29.</td>
<td>CONTROL SWITCHES / SELECTOR SWITCHES</td>
<td>ABB / ALSTOM / BCH / KAYCEE / GEPOWER / SIEMENS</td>
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<tr>
<td>SL.NO.</td>
<td>SUB GROUP</td>
<td>MAKES</td>
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<tr>
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<tr>
<td>30.</td>
<td>PUSH BUTTONS</td>
<td>BCH / L&amp;T / SCHNEIDER / SIEMENS / GEPOWER</td>
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<td>31.</td>
<td>TIMERS/TIME DELAY RELAY</td>
<td>ABB / BCH / L&amp;T / GEPOWER / SIEMENS / EAPL</td>
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<tr>
<td>32.</td>
<td>AUXILIARY RELAYS</td>
<td>ABB / BCH / L&amp;T / SCHNEIDER / GEPOWER / SIEMENS</td>
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<tr>
<td>33.</td>
<td>MASTER CONTROLLER</td>
<td>EPCC (KAKKU) / SCHNEIDER / SIEMENS / STROMKRAFT / TELEMECANIQUE</td>
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<td>34.</td>
<td>LIMIT SWITCHES</td>
<td>EPCC (KAKKU) / BACH / SCHNEIDER / GEPOWER / JAIBALAJI / SCHNEIDER / SIEMENS</td>
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<tr>
<td>35.</td>
<td>PULL CORD SWITCHES</td>
<td>EPCC (KAKKU) / AG MECHANIC / ESSEN / GEPOWER / JAYSHREE ENTERPRISES / STROMKRAFT / PROTO CONTROL</td>
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<td>36.</td>
<td>BELT SWAY SWITCH</td>
<td>EPCC (KAKKU) / AG MECHANIC / TELEMACH / JAYSHREE ENTERPRISES / STROMKRAFT / PROTO CONTROL</td>
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<td>37.</td>
<td>GRAVITY TYPE LIMIT SWITCH</td>
<td>EPCC (KAKKU) / STROMKRAFT / KAYCEE</td>
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<td>38.</td>
<td>ROTARY LIMIT SWITCH</td>
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<td>39.</td>
<td>PROXIMITY &amp; PHOTO ELECTRIC SENSORS</td>
<td>ROCKWELL / SCHNEIDER / SIEMENS/ OMRON / SICK / DELTA / LINE &amp; LINDE / TELEMECANIQUE</td>
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<td>40.</td>
<td>PULSE ENCODER</td>
<td>HUBNER / HEIDENHEIN / ROCKWELL AUTOMATION (ALLEN BRADLEY) / LEONARD BAUR GERMANY / SICK (GERMANY)</td>
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<td>41.</td>
<td>INDICATING LAMP LED TYPE</td>
<td>SIEMENS / L&amp;T / BINAY / ESSEN / BCH / VAISHNO</td>
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<td>42.</td>
<td>HOOTER / BUZZER / BELL / SIRENS</td>
<td>EPCC (KAKKU) / KHERAJ</td>
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<td>43.</td>
<td>SOLID STATE ANNUNCIATOR</td>
<td>ADVANI OERLIKON / AREVA / APLAB / CONTROL &amp; DYNAMICS / DIGICON INSTRUMENTATION LTD. / L&amp;T / MINILEC</td>
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<td>44.</td>
<td>TEMP. SCANNER</td>
<td>ADVANI OERLIKON / ECIL / INSTRUMENTATION LTD. / MASIBUS / PYROTECH / SIEMENS</td>
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<tr>
<td>45.</td>
<td>LAMPS</td>
<td>BAJAJ / CROMPTON GREAVES / GE LIGHTING / PHILIPS / OSRAM / SIGMA</td>
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<tr>
<td>46.</td>
<td>LIGHT FITTING (FIXTURES)</td>
<td>BAJAJ / CROMPTON GREAVES / GE LIGHTING / PHILIPS</td>
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<td>SL.NO.</td>
<td>SUB GROUP</td>
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<td>47.</td>
<td>LIGHTING WIRE (PVC)</td>
<td>CCI / DELTON / FINOLEX / NICCO / UNIVERSAL</td>
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<tr>
<td>48.</td>
<td>5A/15A PIANO SWITCH</td>
<td>ANCHOR / ELLORA / MDS LEGRAND / PRECISION / HAVELLS</td>
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<tr>
<td>49.</td>
<td>FLAME PROOF LIGHT FITTING</td>
<td>GOVAN / BALIGA / FLEXPRO / SUDHIR / CEAG / FCG / SIGMA</td>
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<td>50.</td>
<td>EXHAUST FANS</td>
<td>CGL / KHAITAN / BAJAJ</td>
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<td>51.</td>
<td>CEILLING FANS</td>
<td>CGL / KHAITAN / HAVELS</td>
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<td>PERSONAL COMPUTER</td>
<td>HP / DELL. / LENOVO / IBM</td>
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<td>53.</td>
<td>LAP TOP/ NOTEBOOK</td>
<td>IBM / HP / LENOVO / DELL</td>
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<tr>
<td>54.</td>
<td>HRC FUSE (SEMICONDUCTOR PROTECTION)</td>
<td>BUSMANN / JE MULLER / FERRAZ / GEPOWER / SIEMENS</td>
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<td>55.</td>
<td>ELECTRONIC WEIGHING SYSTEM</td>
<td>ABB / SARTORIOUS / SANMAR / SCHENK / TRANSWEIGH / KELK</td>
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<tr>
<td>56.</td>
<td>PVC POWER CABLES (LT)</td>
<td>CCI / UNIVERSAL / NICCO / RPG CABLES (ASIAN) / POLY CAB / FINOLEX / TORRENT / HAVELLS</td>
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<tr>
<td>57.</td>
<td>PVC CONTROL CABLES</td>
<td>CCI / LAPP / NICCO / RPG CABLES (ASIAN) / UNIVERSAL / POLY CAB / FINOLEX / TOSHNIWAL / DELTON</td>
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<td>58.</td>
<td>HEAT RESISTANT CABLES (EPR/CSP &amp; SR)</td>
<td>CCI / LAPP / NICCO / RPG CABLES (ASIAN) / UNIVERSAL / TOSHNIWAL / DELTON</td>
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<tr>
<td>59.</td>
<td>SCREENED CABLES &amp; SPECIAL CABLES</td>
<td>CCI / BELDEN / LAPP / FINOLEX / POLY CAB / NICCO / TOSHNIWAL / DELTON</td>
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<td>60.</td>
<td>CABLE TERMINATION KITS (XLPE)</td>
<td>MSEAL, 3M / RAYCHEM</td>
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<td>61.</td>
<td>TERMINAL CONNECTOR</td>
<td>CONNECT WELL / ESSEN-DINKY / PHOENIX / WAGO / LAPP</td>
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<td>62.</td>
<td>TRAILING CABLES</td>
<td>LAPP / CCI / UNIVERSAL / ASIAN / NICCO</td>
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<td>63.</td>
<td>WELDING SOCKET</td>
<td>BCH / SCHNIDER / BEST &amp; CROMPTON / GEPOWER / HAVELL / JAIBALAJI</td>
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<td>64.</td>
<td>LIFTING MAGNETS</td>
<td>ELECTROMAG / EPCC (KAKKU) / STERLING MAGNETICS / SUPERLIFT</td>
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<td>65.</td>
<td>POWERPACK FOR MAGNETS</td>
<td>ELECTROMAG / BCH / EPCC (KAKKU)</td>
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<td>66.</td>
<td>RESISTORS (CRANE)</td>
<td>BCH / ELECTROMAG / AMP CONTROL / EPCC / SIEMENS / RESITECH / NARKHEDGE</td>
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<td>67.</td>
<td>LT CAPACITORS</td>
<td>GEPOWER / ABB / CGL / UNI STAR / BHEL</td>
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<td>68.</td>
<td>CABLE REELING DRUM</td>
<td>BENGAL TECHNOCRAT / ELECTRO ZAVOD / EPCC</td>
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<td>69.</td>
<td>DC ELECTROMAGNETIC BRAKE</td>
<td>BCH</td>
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<td>70.</td>
<td>ELECTRO MAGNETIC OVERLOAD RELAYS</td>
<td>BHARAT HEAVY ELECTRICALS LTD / BHARTIA CUTLER-HAMMER LTD / KILBURN ELECTRICALS LTD.</td>
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<td>71.</td>
<td>OIL DASH POT OVERLOAD RELAYS</td>
<td>KILBURN ELECTRICALS LTD / ELECTROGEAR</td>
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<td>72.</td>
<td>CONTROL TRANSFORMERS</td>
<td>SIEMENS LTD / INDCO MANUFACTURING CO / INTRAVIDYUT / AUTOMATIC ELECTRIC LTD. (AE) / INDUSHREE / BHARTIA CUTLER-HAMMER LTD.</td>
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<td>73.</td>
<td>CRANE CONTROL PANELS</td>
<td>HINDUSTAN CONTROL / ECC / VENUS / MEDITRON / EPCC</td>
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C) FIRE DETECTION & ALARM. (F.D.A) SYSTEM

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<tr>
<th>SL.NO</th>
<th>DEVICES</th>
<th>MAKES</th>
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<tr>
<td>1.</td>
<td>INTELLIGENT DETECTORS (PHOTO ELECTRIC, HEAT, THERMAL)</td>
<td>SIMPLEX / NOTIFIER / EDWARDS</td>
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<td>INTELLIGENT FIRE ALARM CONTROL PANELS</td>
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<td>ADDRESSABLE MANUAL CALL POINTS INCLUDING HAND SETS</td>
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<td>MONITOR MODULES</td>
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<td>FAULT ISOLATION MODULE</td>
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<td>CONTROL MODULES</td>
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<td>UV FLAME DETECTORS</td>
<td>PATOL / DETRONICS / SPECTREX</td>
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<td>BEAM DETECTORS</td>
<td>EDWARDS / NOTIFIER / SIMPLEX</td>
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<td>IR FLAME DETECTORS</td>
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<td>UL / FM / APPROVED</td>
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<td>KIDDE / L.G.M / PATOL</td>
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<td></td>
<td>A) WITH METAL BRAID STEEL/BRONZE, COPPER</td>
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<td>B) WITH NYLON BRAID</td>
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<td>UL / FM / APPROVED</td>
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<td>DIGITAL LINEAR HEAT SENSING CABLE</td>
<td>KIDDE / L.G.M / PATOL</td>
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<td>A) WITH NYLON BRAID</td>
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<td>B) WITH METAL BRAID STEEL, BRONZE, COPPER</td>
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<td></td>
<td>UL / FM / APPROVED</td>
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<td>CONTROL UNIT FOR DIGITAL LHS CABLE</td>
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<td>VIDEO DISPLAY UNIT INCLUDING CPU, PC, MONITOR, PRINTER ETC.</td>
<td>DELL / HP / HCL / WIPRO / IBM</td>
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<td>13</td>
<td>SIREN</td>
<td>KHERAJ / BEMCO / TULU</td>
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<td>CABLES</td>
<td>BELDON / SOUTHWEST / ALPHA</td>
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<td>A: FOR DETECTOR CABLING</td>
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<td>(I) IMPORTED</td>
<td>FINOLEX / DELTON / UNIVERSAL / NICCO / POLYCA / FORTGLOSTER / HAVELLS</td>
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<td>16</td>
<td>SIGNAL CABLE</td>
<td>USHA BELTON / HCL / DELTON / VINDHYA TELELINK</td>
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<td>17</td>
<td>M.S. CONDUIT AS PER IS-9537-PART-II-1981</td>
<td>NICCO / BHARAT / ZENITH / BEC / CENTURY</td>
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<td>18</td>
<td>GI CONDUITS</td>
<td>BEC / NICCO / ZENITH</td>
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<td>19</td>
<td>ROAD CROSSING G.I PIPES</td>
<td>NICCO / TATA / JINDAL</td>
</tr>
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| 20 | F.D.A SYSTEM SUPPLIERS | 1. ELECTRONICS CORPORATION OF INDIA LTD.  
2. TECHNICAL TRADE LINKS PVT. LTD.  
3. GUNNEBO INDIA LTD.  
4. MATHER & PLATT PUMPS (I) LTD.  
5. M/S AGNICE FIRE PROTECTION LIMITED.  
6. M/S TECHNICO (INDIA) PVT. LIMITED.  
7. NOTIFIER.  
8. SIEMENS.  
9. TECHNO FIRE.  
10. NEW FIRE.  
11. TYCO FIRE & SECURITY. |
| 21 | ELECTRONIC PRIVATE AUTOMATIC BRANCH TELEPHONE EXCHANGE (EPABX) SUPPLIERS | 1. M/S INDIAN TELEPHONE INDUSTRIES LIMITED.  
2. M/S AVAYA GLOBAL CONNECT LIMITED.  
3. M/S SIEMENS LIMITED.  
4. M/S ALCATEL.  
5. M/S B.P.L TELECOM PVT. LIMITED.  
6. M/S CROMPTION GREAVES LIMITED.  
7. ERICSSON. |
| 22 | C.C.T.V SYSTEM SUPPLIERS | 1. M/S E.C.I.L.  
2. M/S NELCO LIMITED.  
3. M/S DATAMATICS INFORMATION TECHNOLOGY LIMITED.  
4. M/S PHILIPS/BOSCH  
5. M/S PELCO |
### General Technical Specification

**Preferred Makes**

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<table>
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<tr>
<th>Sl. No.</th>
<th>Item Description</th>
<th>Preferred Makes</th>
</tr>
</thead>
</table>
| 23      | LOUD SPEAKER TALK BACK(LSTB) / LOUD SPEAKER INTERCOMMUNICATION(LSIS) SYSTEMS SUPPLIERS | 1. M/S POWER SYSTEMS.  
2. PHI-AUDIOCOM.  
3. M/S MOTAWANE PRIVATE LIMITED |
| 24      | TELEPHONE CABLE SUPPLIERS | 1. DELTON CABLES.  
2. TELE-LINK NICCO.  
3. FINOLEX. |
| 25      | FIBRE OPTIC (F.O) CABLE. | MOLEX/LUCENT/AMPHINOL/BIRLA ERICSSON/OPTEL. |
| 26      | V.H.F SYSTEM | MOTORALA/ YEASU/SIMOCO/ADINO |

### 07. INSTRUMENTATION

**A. Field Instruments:**

1. **Pressure / Differential Pressure gauge**: WIKA, Manometer India, A.N. Instruments, Precision Industries, General Instruments, Waaree instruments, Forbes Marshall, Walchandnagar (Tiwac), Hirlekar (DP gauge)

2. **Pressure / Differential Pressure switches**: Ifm. WIKA, Kasturba (Orion-Ashcroft), Switzer, Indfoss, Vasutech,

3. **Pressure / Differential Pressure Transmitters**: Emerson (Rosemount), Chemtrols (Fuji), Honeywell, Yokogawa, Siemens, ABB

4. **Temperature gauges**: WIKA, Manometer India, A.N. Instruments, General Instruments, Waaree instruments, GE gauges, Walchandnagar, Precision Industries.

5. **Thermocouple & RTD / thermowell**: General Instruments, Nagman Instruments, Toshniwal
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<th>Sl. No.</th>
<th>ITEM DESCRIPTION</th>
<th>PREFERRED MAKES</th>
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<tbody>
<tr>
<td>6.</td>
<td>Temperature Switch</td>
<td>WIKA, Manometer India, A.N.Instruments, General Instruments, Indfoss, Switzer, Vasutech.</td>
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<tr>
<td>7.</td>
<td>Temperature transmitter</td>
<td>Emerson (Rosemount), Yokogawa, Honeywell, Siemens, Fuji (Chemtrols,) , ABB</td>
</tr>
<tr>
<td>9.</td>
<td>Orifice Plate &amp; flanges Assembly/ Venturi, Flow nozzle</td>
<td>Engineering Specialities, Micro-precision, Hydro-pneumatics, Chemtrols-Samil, Instrumentation Ltd,</td>
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<tr>
<td>10.</td>
<td>DP type Flow / Level Transmitters</td>
<td>Emerson (Rosemount), Chemtrols (Fuji), Honeywell, Yokogawa, Siemens , ABB</td>
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<tr>
<td>12.</td>
<td>Electromagnetic flow meter</td>
<td>Yokogawa, Emerson (Rosemount), Krohne-Marshall, Endress &amp; Hauser, ABB</td>
</tr>
<tr>
<td>13.</td>
<td>Vortex Flow meter</td>
<td>Emerson(Rosemount), Krohne -Marshall, Yokogawa, Vortex Instruments</td>
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<td>16.</td>
<td>Level Switch (Conductivity type)</td>
<td>Chemtrol (Vega), Endress &amp; Hauser, Switzer Instruments, SB Electro-mechanical, Techtrl, Nivo Controls, Level-Tech</td>
</tr>
<tr>
<td>17.</td>
<td>Level Switch (Capacitance/RF type)</td>
<td>Chemtrol (Vega), Endress &amp; Hauser, Switzer Instruments, SB Electro-mechanical, Techtrl, Nivo Controls, Level-Tech</td>
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<tr>
<td>18.</td>
<td>Level Switch (Tuning fork/ Rod type)</td>
<td>Chemtrol (Vega), Endress &amp; Hauser, S.B. Electro-mechanical, Nivo Controls</td>
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<tr>
<td>19.</td>
<td>Level Switch (Float type)</td>
<td>Emerson,Trac, Chemtrols, Forbes Marshall, D K Instruments, Levcon Instruments, Techtrl , V-Automat, Warree</td>
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<td>Sl. No.</td>
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<td>PREFERRED MAKES</td>
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<tr>
<td>--------</td>
<td>----------------------------------------</td>
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<tr>
<td>20.</td>
<td>Level Switch/ Transmitter (Displacer type)</td>
<td>Emerson, Chemtrols (Eckard), Trac, D K Instruments, Levcon Instruments,</td>
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<td>21.</td>
<td>Level Switch/ Transmitter (Ultrasonic type)</td>
<td>Chemtrol (Vega), Endress &amp; Hauser, Krohne Marshall, Siemens (Miltronics), Toshbro controls (Enraf)</td>
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<td>22.</td>
<td>Level Switch/ Transmitter (Radar type)</td>
<td>Chemtrol (Vega), Emerson (Rosemount), Endress &amp; Hauser, Toshbro controls (Enraf), Krohne-Marshall</td>
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<td>23.</td>
<td>Level Switch/ Transmitter (Nucleonic type)</td>
<td>Concord International (Dr. Berthold), Emerson (Kay Ray), ECIL.</td>
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<td>28.</td>
<td>Electro-hydraulic actuator</td>
<td>Reineke, Askania</td>
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<tr>
<td>33.</td>
<td>Solenoid Valve</td>
<td>Burkert, Herion, Rotex, Schrader-Schovill, Jucomatic, Avcon, Asco</td>
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### B. Control room Instrumentation

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<tr>
<td>34.</td>
<td>Air filter regulator</td>
<td>Shavo-Norgren, Marsh-Bellofram, Placka, Schrader-Schovill.</td>
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</table>

#### 1. Distributed Control System (DCS)
- Yokogawa (CS 3000), Honeywell (Experion +C 300), ABB (AC 800 XA), Emerson (Delta V), Siemens (PCS 7+S7400H).

#### 2. Programmable Logic Controllers.
- Refer Electrical list.

#### 3. Digital Indicator
- Pyrotech Electronics, Lectrotek, Chino-Laxsons, Micro systems, Master Electronics, Masibus Instruments, Ranutrol, Honeywell.

#### 4. Bargraph Indicator
- Chino-Laxsons, Masibus Instruments, Pyrotech Electronics, Lectrotek, Teletherm, Ranutrol

#### 5. Recorders (Chart Less)
- Eurotherm, Yokogawa, Chino-laxsons, Honeywell, Siemens, ABB.

#### 6. Microprocessor based controller
- Yokogawa, Siemens, Honeywell, Eurotherm, Fuji, ABB, Forbes Marshall, Toshiba

#### 7. Digital scanners
- Lectrotek, Micro systems, Master Electronics, MB controls, Masibus Instruments, Procon.

#### 8. DC Power Supply Unit
- Aplab, Elnova, Siemens, Phoenix, Schneider,

#### 9. IS Interface/Zenner Barrier
- Pepperl & Fuchs, MTL, Stahl

#### 10. Signal isolators
- Pepperl & Fuchs, MTL, Stahl, Yokogawa, Forbes Marshall (Protech), Chino-Laxsons, Phoenix

#### 11. Annunciation system

#### 12. Instrument Panels/ Control Desk
- Rittal, Pyrotech, Radha Krishna Controls, Instrumentation Ltd.

#### 13. Instrumentation Cable
- Universal Cables, Delton, Thermopads, KEI industries, Paramount Cables, Lapp cables, Cords cables, Uniflex cables, Brooks Cables, Elkay Telelinks, Rajinigandha, Special Cables, TCL Cables, Friends Cable, Daksha Cable, Crystal Cables, Udey Pyro-Cables, Elkay Telelinks, Fort Gloster
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>ITEM DESCRIPTION</th>
<th>PREFERRED MAKES</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.</td>
<td>Thermocouple Compensating Cable</td>
<td>Toshniwal Cables, General Instruments, Paramount Cables, Udey pyro-cables, Cords cables, Brooks, Daksha Cables, Friends Cable.</td>
</tr>
<tr>
<td>C.</td>
<td>Analytical / Special Instruments</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Gas analysis Instruments</td>
<td>ABB (H&amp;B), MSA, Emerson, Siemens, Chemtrols (Maihak), Forbes Marshall, Fuji, Beiler &amp; lang (CO-Monitor), Honeywell, Yokogawa.</td>
</tr>
<tr>
<td>3.</td>
<td>Calorific Value (CV) analyzers</td>
<td>Reineke, Union. Yokogawa</td>
</tr>
<tr>
<td>4.</td>
<td>Moisture Analyzers (Nucleonic)</td>
<td>Concord International (Dr. Berthold), Emerson (Analytical)</td>
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<tr>
<td>6.</td>
<td>Moisture Sensor &amp; Transmitter</td>
<td>Invensys (Foxboro), Bartec, GE-Panametrics</td>
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<tr>
<td>7.</td>
<td>Flame Detector</td>
<td>Honeywell, Durag Instruments</td>
</tr>
<tr>
<td>8.</td>
<td>Vibration sensors &amp; monitors</td>
<td>Bentley Nevada, Schenck -Avery, Josts Engineering (Bruel &amp; Kjaer), SPM Instruments, Mechanalysis India (IRD).</td>
</tr>
<tr>
<td>10.</td>
<td>Annubar / Flow tube</td>
<td>Emerson, Switzer Instruments.</td>
</tr>
<tr>
<td>11.</td>
<td>Infrared radiation pyrometer</td>
<td>Land, Chino-Laxsons, Toshniwal (Raytek), Ircon, Nagman (Wahl),</td>
</tr>
<tr>
<td>12.</td>
<td>Dip lance type Molten metal temperature measurement system &amp; T/C Tips</td>
<td>Ardee Enterprise (Electronite), Ferrotran</td>
</tr>
<tr>
<td>13.</td>
<td>Slag detection system</td>
<td>Elof Hanson (EMLI), Land.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>ITEM DESCRIPTION</td>
<td>PREFERRED MAKES</td>
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</tr>
<tr>
<td>15.</td>
<td>SOx- NOx analyser</td>
<td>Forbes Marshall, Emerson, Yokogawa, ABB, Honeywell</td>
</tr>
</tbody>
</table>

08. FIRE PROTECTION SYSTEM

1. Steel pipes                   - SAIL, ITC, JINDAL, Ajanta, Maharasra Seamless, Prakash Tubes Gujarat Steel tubes,
2. Steel pipes fittings          - Tube Bends, Jindal, Ajanta Shivananda, EBY Industries.
5. Outside coating& Wrapping for pipes - Llyods/STP
7. Diesel Engine                 - Kirloskar-Cummins, Crompton-Greaves, Ashok Leyland
8. Fire extinguishers            - New Fire, VIPL, Zenith, ASCO Strumech
10. Passive Fire protection

09. **BOF GCP EQUIPMENTS:-**

Following equipment/supplies specific to BOF-Gas Cleaning Plant shall be manufactured by any of the following vendors listed below:-

- Insulation, Techno Fire Controls
- New Fire Engineers
- Llyod, 3M, Vijay System, Signum
<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>EQUIPMENT</th>
<th>VENDOR/MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hood, Stack and Lance sealing device</td>
<td>ISGEC, ACC-BABCOCK (ABL), BHPVL, L &amp; T</td>
</tr>
<tr>
<td>2.</td>
<td>Hood traverse carriage, Stack inspection device, Hood bottom closure device</td>
<td>L&amp;T, WMI CRANES, JESSOP, MUKAND</td>
</tr>
<tr>
<td>3.</td>
<td>Pressure vessels - Expansion vessel, Mixing drum, Make-up water tank, Sample cooler, Blow-down &amp; drainage expansion tanks and Emergency spray vessel</td>
<td>ISGEC, ABL, BHPVL, TSL, KAVERI ENGG.</td>
</tr>
<tr>
<td>4.</td>
<td>Additive feeding system</td>
<td>BEEKAY, SIMPLEX, MUKAND</td>
</tr>
<tr>
<td>5.</td>
<td>Gas holder</td>
<td>MICCO, SMS-DEMAG, CLAYTON – WALKER</td>
</tr>
<tr>
<td>6.</td>
<td>Fabricated gas ducts (Dia&gt; 1200 mm), Trestles/Duct Supports, Flare stack structure Walkways/Accesses</td>
<td>BEEKAY, ROURKELA FABRICATION, BHARAT WEST – FALIA, SUBURBAN ENGG., KM UDYOG, OTTO, APV</td>
</tr>
<tr>
<td>7.</td>
<td>Electrostatic precipitator (wet type)</td>
<td>VOLTAS, OTTO, ORIENT, ANDREW YULE</td>
</tr>
<tr>
<td>8.</td>
<td>ID fan</td>
<td>NEU (France), JAMES HOWDEN (UK), ROTHemuHLE (Germany), DONKIN (UK), FLAKTWoods</td>
</tr>
<tr>
<td>9.</td>
<td>Centrifugal horizontal CW pumps</td>
<td>INGERSOLL, SULZER</td>
</tr>
</tbody>
</table>

Fabricated equipments
- Stack cover plate, Saturator, Hydraulic seal Recycling tank, Convergent/Divergent ducts, Changeover device, Hydraulic non-return valve, Condensate seal pots, Sump cover

<table>
<thead>
<tr>
<th>VENDOR/MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHEC, BHPVL, KCP, BINNY ENGG. WORKS, ABL, ISGEC, OTTO</td>
</tr>
</tbody>
</table>
- For any other equipment/supplies which are not covered above, the make/manufacturer’s name shall be mutually agreed between Purchaser/Consultant and the successful Tenderer.

10. INFORMATION SYSTEM

Preferred Makes for Level-II automation

Server Computers : IBM/HP/SUN

Client Computers (PC) : IBM/Lenovo/HP-Compaq/DELL

Network Equipment
• Active components : CISCO
• Passive components : LUCENT/AMP

Application software including
Process control models : Technology Supplier
## 11. FLUID SYSTEMS & PIPING ENGG (LUBRICATION & HYDRAULICS)

### PREFERRED MAKE OF ITEMS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>ITEM</th>
<th>MAKE</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Piston / Vane Pumps &amp; Hydraulic Motors</td>
<td>Rexroth / Parker / Kawasaki / Eaton</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>2</td>
<td>Gear Pump</td>
<td>Del Pd Pumps (ROTODEL) / Tushaco / Rexroth / Parker / Alfa</td>
<td>Hydraulics / Oil Lubrication</td>
</tr>
<tr>
<td>3</td>
<td>Screw Pump</td>
<td>IMO / Allwiler / Nortek</td>
<td>Hydraulics / Oil Lubrication</td>
</tr>
<tr>
<td>4</td>
<td>Centrifugal Pump for Descaling System</td>
<td>KSB / Halberg / Wier</td>
<td>Descaling</td>
</tr>
<tr>
<td>5</td>
<td>Piston Pump for Descaling System</td>
<td>Uraca / Wepuko / Hauhinco</td>
<td>Descaling</td>
</tr>
<tr>
<td>6</td>
<td>Centrifugal Pump (12 Bar &amp; below)</td>
<td>KSB / Kirloskar / Voltas / Mather &amp; Platt / Beacon / Wier</td>
<td>Water</td>
</tr>
<tr>
<td>7</td>
<td>Submersible Type Sump Pump</td>
<td>KSB / Flygt / Grundfos</td>
<td>Sump</td>
</tr>
<tr>
<td>8</td>
<td>Grease Lubrication System</td>
<td>Lincoln Helios / Bijur Delimon / Nortek</td>
<td>Grease</td>
</tr>
<tr>
<td>9</td>
<td>Oil Lubrication System</td>
<td>Lincoln Helios / Shaan Lube</td>
<td>Oil Lubrication</td>
</tr>
<tr>
<td>10</td>
<td>Air Oil System</td>
<td>Rebs / Dropsa / Bijur Delimon / Nortek</td>
<td>Air-Oil Lubrication</td>
</tr>
<tr>
<td>11</td>
<td>Air Controls</td>
<td>Rotex, / Schrader Duncan / Shavo Norgren / Nucon / Ross / SMC / Rexroth / Parker</td>
<td>Pneumatics</td>
</tr>
<tr>
<td>12</td>
<td>Hydraulic Proportional Valve</td>
<td>Rexroth / Parker / Eaton / Yuken (Japan)</td>
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<tr>
<td>13</td>
<td>Hydraulic System</td>
<td>Rexroth / Parker / Eaton / Yuken</td>
<td></td>
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<tr>
<td>14</td>
<td>Hydraulic Control Valve</td>
<td>Rexroth / Parker / Eaton / Yuken</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>15</td>
<td>Hydraulic Servo Valve</td>
<td>Moog / Rexroth</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Manual Valves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.1</td>
<td>Manual Gate / Globe Valves with &amp; without gear for High Pressure application</td>
<td>KSB / BHEL / AUDCO / BDK</td>
<td>Oil Lubrication / Descaling</td>
</tr>
<tr>
<td>16.2</td>
<td>Manual Gate / Globe Valves with &amp; without for Low Pressure application (16 Bar and Low)</td>
<td>KSB / BHEL / VIRGO / AUDCO / BDK / Fouress / Akay</td>
<td></td>
</tr>
<tr>
<td>16.3</td>
<td>Butterfly Valve</td>
<td>AUDCO / VIRGO / BDK</td>
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<tr>
<td>16.4</td>
<td>Ball Valve</td>
<td>AUDCO / FOURRESS / BDK / VIRGO</td>
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</tr>
<tr>
<td>16.5</td>
<td>Check Valve (Disc Type)</td>
<td>AUDCO / BDK / FOURRESS</td>
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<tr>
<td>SL. NO.</td>
<td>ITEM</td>
<td>MAKE</td>
<td>AREA</td>
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<tr>
<td>16.6</td>
<td>Check Valve (Spring Loaded) – Low Pressure</td>
<td>AUDCO / BDK / FOURESS</td>
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<tr>
<td>16.7</td>
<td>Check Valve (Spring Loaded) – High Pressure</td>
<td>AUDCO / BDK</td>
<td></td>
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<td>16.8</td>
<td>Check Valve (Disc Type) – High Pressure</td>
<td>AUDCO / BDK</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Control Valve for oil lubrication system</td>
<td>Forbes Marshall / Samsung / Fisher / RK Controls / Nirmal Industrial Controls</td>
<td>Oil Lubrication</td>
</tr>
<tr>
<td>18</td>
<td>Spray Valve for Descaling System</td>
<td>Hunt / Elwood</td>
<td>Descaling</td>
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<tr>
<td>19</td>
<td>Air Release Valve</td>
<td>Upadhyay / Steam &amp; Mining / BDK</td>
<td>Water</td>
</tr>
<tr>
<td>20</td>
<td>Air / Gas Safety Relief Valve</td>
<td>Moorco / L &amp; T / Fainger / Mankenberg</td>
<td>Descaling</td>
</tr>
<tr>
<td>21</td>
<td>Actuators for operating Valves</td>
<td>L &amp; T / Virgo / Rotex / AVCON</td>
<td>Oil Lubrication</td>
</tr>
<tr>
<td>22</td>
<td>Accumulator with safety shut off block</td>
<td>Christie / Hydac / Parker / EPE</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>23</td>
<td>Accumulator Charging Kit</td>
<td>Christie / Hydac / Parker / EPE</td>
<td>Hydraulics</td>
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<tr>
<td>24</td>
<td>Accumulator for Descaling System</td>
<td>WSR / BHPV / ISGEC</td>
<td>Descaling</td>
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<tr>
<td>25</td>
<td>Pressure Filter</td>
<td>Hydac / Pall / Internormen / Parker</td>
<td>Hydraulics</td>
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<tr>
<td>26</td>
<td>Return Filter</td>
<td>Hydac / Pall / Internormen / Parker</td>
<td>Hydraulics</td>
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<td>27</td>
<td>Basket Filter</td>
<td>Internormen / Hydac / Pall / Ball Filters</td>
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<td>Auto Back wash Filter</td>
<td>Ball &amp; Kirch, / Hydac / Fluid engineering</td>
<td>Descaling / Water</td>
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<td>Basket Strainer for water</td>
<td>Superflo / Hydac / EPE / Internormen / Multitex</td>
<td>Hydraulics / Oil Lubrication</td>
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<td>30</td>
<td>HP Compressor</td>
<td>Ingersoll Rand / Aerotechnic Coltri</td>
<td>Descaling</td>
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<td>31</td>
<td>Heat Exchanger</td>
<td>Alfa Laval / Indswep / Tranter</td>
<td>Hydraulics / Oil Lubrication</td>
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<td>32</td>
<td>Level Indicator Switch</td>
<td>Sigma / Levcon / Shridhan / Magnetrol / Buhler / Tectral / WEKA / Peneberthy / Kobold</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
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<td>33</td>
<td>Pressure Gauge &amp; Temperature Gauge</td>
<td>A.N. Instruments / H.Guru / Wika / Forbes Marshal / Stauff / Hydac / kobold</td>
<td>Hydraulics / Oil Lubrication / Descaling / Utility Services</td>
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<td>34</td>
<td>Pressure Switch</td>
<td>Rexroth / Switzer / Hydac / Parker / Dadfoss (Indfoss) / Kobold</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
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<td>35</td>
<td>Differential Pressure</td>
<td>Fisher Rosemount / Forbes</td>
<td>Descaling</td>
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<td>SL. NO.</td>
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<tr>
<td>Transmitter</td>
<td>Marshall</td>
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<td>36</td>
<td>Thermostat</td>
<td>Switzer / Hydac / Stauff / Verma Trafag / Johnson Control / Kobold</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
</tr>
<tr>
<td>37</td>
<td>Differential Pressure Gauge cum Switch</td>
<td>Switzer / Danfoss / Indfoss / Hydac</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
</tr>
<tr>
<td>38</td>
<td>Pressure Transmitter</td>
<td>Hydac / Forbes Marshall</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>40</td>
<td>Flowmeter cum Totaliser</td>
<td>Rockwin / Forbes Marshall</td>
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<tr>
<td>41</td>
<td>Pipes / Tubes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.1</td>
<td>Carbon Steel Seamless Pipes / Tubes</td>
<td>Jindal / Ratnamani / Maharashtra Seamless / MJ Patel / Indian Seamless / Gandhi Special Tubes / BHEL</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
</tr>
<tr>
<td>41.2</td>
<td>Stainless Steel Seamless Pipes / Tubes</td>
<td>Jindal / Choksi Tubes / Ratnamani / MJ Patel</td>
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<td>41.3</td>
<td>Carbon Steel ERW - SAW Pipes / Tubes</td>
<td>Maharashtra Seamless / MJ Patel / Gandhi Special Tubes / SAIL / Jindal Saw / Ratnamani / Surya Roshni / MAN / Wellspun</td>
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<td>42</td>
<td>Pipes / Tubes Fittings</td>
<td>Hyd-air / Hyloc Hydrotechnic / MS Fittings / NL Hazra / Project Tooling Systems / Tube Bend / Parker / AVIT / Zest Technologies</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
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<tr>
<td>43</td>
<td>Clamps (Polypropylene Clamp, U-Bolts)</td>
<td>Project Tooling Systems / Stauff / Hydair</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
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<td>44</td>
<td>Hose with end fittings</td>
<td>Hydrokrimp / Indo-industrial / Hydrolines / Superseals / Parker</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
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<td>45</td>
<td>Flanges</td>
<td>Echjay / NL Hazra / MS Fittings</td>
<td>Hydraulics / Oil Lubrication / Descaling</td>
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<td>46</td>
<td>SAE Flange</td>
<td>AVIT / Parker / Hyloc / Stauff</td>
<td>Hydraulics</td>
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<tr>
<td>47</td>
<td>Electrical Heater</td>
<td>Escorts / Alco / Helios</td>
<td>Hydraulics / Oil Lubrication</td>
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<tr>
<td>48</td>
<td>Air Breathers</td>
<td>Internormen / Parker / Hydac</td>
<td>Hydraulics / Oil Lubrication</td>
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<tr>
<td>49</td>
<td>Portable Filter Unit</td>
<td>Internormen / Hydac / Rexroth /</td>
<td>Hydraulics</td>
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<tr>
<td>SL. NO.</td>
<td>ITEM</td>
<td>MAKE</td>
<td>AREA</td>
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</tr>
<tr>
<td>50</td>
<td>Contamination Analysis Kit</td>
<td>PALL / Hydac / Internorm / Parker</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>51</td>
<td>Centrifuge</td>
<td>Alfa Laval / Westfalia</td>
<td>Hydraulics / Oil Lubrication</td>
</tr>
<tr>
<td>52</td>
<td>Vacuum Dehydrator</td>
<td>Filtervac / Pall / Parker / Nortek</td>
<td>Hydraulics / Oil Lubrication</td>
</tr>
<tr>
<td>53</td>
<td>Electrostatic Liquid Cleaner</td>
<td>KLEENTEK / Ferrocare</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>54</td>
<td>Mobile Motorised Pump-Motor-Filter Unit for Oil Filling</td>
<td>PALL / Hydac / Internorm / Parker</td>
<td>Hydraulics / Oil Lubrication</td>
</tr>
<tr>
<td>55</td>
<td>Chain Pulley Blocks &amp; Hand Operating Traveling Cranes</td>
<td>Batliboi / Moris / WH Brady &amp; Co.</td>
<td>Hydraulics / Oil Lubrication</td>
</tr>
<tr>
<td>56</td>
<td>Spray Nozzles</td>
<td>Lechler / Spraying system</td>
<td>Descaling / Gear boxes</td>
</tr>
<tr>
<td>57</td>
<td>Nitrogen Booster Station</td>
<td>Hydac / Parker</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>58</td>
<td>Water in Oil detector</td>
<td>IMA / Parker / UCC</td>
<td>Hydraulics</td>
</tr>
<tr>
<td>59</td>
<td>Lubricating oil</td>
<td>Indian oil / HP / BP / Castrol / Mobil Exxon</td>
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</tr>
<tr>
<td>60</td>
<td>Hydraulic oil</td>
<td>Indian oil / HP / BP / Castrol / Mobile Exxon</td>
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<td>61</td>
<td>Flushing Oil</td>
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<td>62</td>
<td>Grease</td>
<td>Indian oil / HP / BP / Castrol / Balmer Lourie</td>
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<tr>
<td>63</td>
<td>Expansion Joint</td>
<td>ESBI / STANFLEX / ELAFLEX</td>
<td></td>
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</table>
HYDRAULICS
(CHAPTER-14)
GENERAL SPECIFICATION
FOR
HYDRAULICS
(GS – 14)

MECON LIMITED
RANCHI – 834002

No. MEC/S/1901/11/38/00/00/F1889/R2

JULY, 2007
Facilities to be provided in the Hydraulic Power Pack Room.

1) Hydraulic power pack shall be installed in room where adequate provisions are made to keep ambient air free from dust, moisture and ambient temperature shall be kept below 35°C.

2) Adequate facility shall be provided for handing of equipments / components installed in the power pack room.

3) Adequate illumination.

4) Adequate fire alarms, fire protection system and fire fighting facilities.

5) Antiskid tile floor shall be provided in the power pack room.

6) Design of floor shall be such that spilled oil / leakage oil, if any is collected into drain pit and from there, arrangement shall be provided for collection and disposal of leakage oil into oil barrels for reclamation purpose.

7) Emergency doors.

8) Adequate space to carry out maintenance activities.

9) Hydraulic circuit of the system on anodized plate(s) shall be provided.

II Whatever Servo / Proportional Valves are used in the system, supplier shall supply Servo Valve flushing facility and test kits for Servo and Proportional Valves.

III For hydraulic systems with conventional valves, the supply voltage to various controls shall be 24 V DC.

IV BSP’s approved preferred make in vogue shall be followed.

V Mineral oil shall be used in hydraulic systems until otherwise agreed upon by BSP.

VI All the pipes and fittings used in hydraulic systems of critical production units shall be stainless steel until otherwise agreed up on by BSP.

VII Filters shall be provided for continuous removal of contaminants from the hydraulic fluid, which are likely to cause malfunction of pumps, valves and actuators and maintain desired cleanliness level of hydraulic fluid. Adequate
filtration shall be provided for each system considering the ingress rate of contaminants in each applications.

VIII All the pressure line, return line and circulation filters shall be of absolute filtration design with B(x) ratio greater than or equal to 200. Total delta p across filters shall not exceed 0.5 bar with filter element in clean condition. (Total p means pressure drop across clean filter element plus pressure drop filter housing).

The micron rating shall be as specified in T.S. for individual filters.

IX All the hydraulic system shall be provided with dedicated oil purifier. The oil purifier (vacuum dehydrator type) shall be capable to remove undissolved as well as dissolved water and solid containments from the hydraulic oil of the system in a reasonable time to the desired level.

X Portable oil transfer unit with built in filtration facility shall be provided for transfer oil from barrels to oil reservoir of the system.

XI Calibration and Testing Facilities for the Hydraulic Components installed in the hydraulic systems shall be provided as detailed below.

The scope of work covers design, engineering, manufacture, supply, erection, testing and commissioning of following facilities :-

A) Power pack for Test Rigs of conventional control valves, pumps, motors and hydraulic cylinders.

B) Test rig for conventional control valves.

C) Test rig for pumps and motors

D) Test rig for hydraulic cylinders.

E) Test rig and Power pack for Servo and Proportional valves (if Servo / Proportional valves are used / installed in the hydraulic systems).

F) Repair benches for the above components.

G) Cleaning Station for hydraulic components.

H) All connected electrical, instrumentation and automation equipment and accessories.

The scope of supply shall also include all components and accessories as required to render the system complete in all respect.
All the above equipments / components handling facility shall be provided. Adequate facility shall also be provided for storage of components (both un-repaired and repaired / tested components.

The Test Rigs shall have facilities for on-line acquisition of test parameters of the components while testing and shall be transferred to the main computer for records and references.

XII Plate Type Heat Exchangers of adequate capacity shall be provided in the Hydraulic Systems.

XIII The hydraulic system shall have facility for on-line Pressure measurement in P, T, A and B lines at suitable locations of the circuit. Necessary instruments, conditions monitoring system and facilities shall be provided by the supplier.

XIV Necessary training shall be imparted by the supplier to Engineers Technicians with regard to operation and maintenance of the systems.

XV HYDRAULIC PIPE LINE ERECTION, TESTING, PICKLING, FLUSHING AND COMMISSIONING

Hydraulic pipe work shall be assembled, pressure tested, pickled, flushed and commissioned as per piping instructions given by the system designer / consultant.

Provision of pipe line pickling and flushing facility shall be in the scope of work (provision of separate tank, pumps filters elements, pickling and flushing fluids shall be in the supplier’s scope).

Supply of minimum 50 nos. of spare filter elements of each type along with the hydraulic system at the time of Erection, Testing and Commissioning shall be in the supplier’s scope of supply.

Oil cleanliness shall be checked during commissioning and facilities for checking and monitoring oil cleanliness shall be in the bidders scope of supply.

Suppliers Scope of Work in hydraulic pipe work shall also include :-

1) Equipment Supplier shall give a comprehensive cleaning and flushing scheme for hydraulic systems and provide necessary facilities to carry out the activity.

2) Adopt cleaning and flushing guidelines from ISO 5910.
3) Hydraulic System cleaning and flushing documents shall be part of acceptance checks in the Quality Assurance Program. Compliance to this shall be reported in the overall QAP.

4) Develop a plan for how to systematically control hook-up of subsystems into the main system. Documentation of results as part of the total flushing procedure. Describe cleaning and flushing connections and looping methods along with the details of components required to carry out the above.

5) Suppliers to specify sampling points to be used for condition monitoring during flushing and in service.

6) Connection program after cleaning and flushing is over with built-in-check for prevention of contaminants during connections and assembling.

7) Acceptance norms shall be given by the Equipment Designer / Supplier.

XVI All pipelines shall be of seamless type clamped with polypropylene heavy series clamps. However, in the hot zone heavy series aluminum clamps shall be used.

XVII All hydraulic pipe lines shall be painted as per the standard color mode.