HINDUSTAN AERONAUTICS LIMITED, AIRCRAFT DIVISION, NASIK

NAME OF WORK

CIVIL, ELECTRICAL AND OTHER UTILITY SERVICES FOR CONSTRUCTION OF HANGARS, UTILITY BUILDINGS AND ALLIED FACILITIES FOR PACKAGE -CIVIL- II (ROTABLE COMPLEX) IN FACTORY [EXCLUDING PRE-ENGINEERED BUILDING STRUCTURES (PEB)]

TENDER NO.NK/FW-CAP-ROH/577/10-11

VOLUME –II

TECHNICAL SPECIFICATION
TABLE OF CONTENTS

PART –I CIVIL WORKS 01 -244
PART –II – ELECTRICAL WORK 245-364
PART –III – AIR CONDITIONING 365-537
PART –IV – COMPRESSED AIR. & CRANES 538-565
PART –V – LIFT 566-585
PART –VI – FIRE PRODECTION WORK 596-623
# PART-I CIVIL WORKS

<table>
<thead>
<tr>
<th>Section No</th>
<th>Items</th>
<th>Page Nos</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>General Rules</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>List of Indian Standards</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Earthwork Excavation</td>
<td>30</td>
</tr>
<tr>
<td>4.</td>
<td>Concrete Works</td>
<td>42</td>
</tr>
<tr>
<td>5.</td>
<td>Brick Work</td>
<td>60</td>
</tr>
<tr>
<td>6.</td>
<td>Stone Masonry</td>
<td>68</td>
</tr>
<tr>
<td>7.</td>
<td>Wood Work</td>
<td>72</td>
</tr>
<tr>
<td>8.</td>
<td>Joinery Work</td>
<td>77</td>
</tr>
<tr>
<td>9.</td>
<td>Building Hardware</td>
<td>83</td>
</tr>
<tr>
<td>10.</td>
<td>Steel, Iron and Aluminum Works</td>
<td>90</td>
</tr>
<tr>
<td>11.</td>
<td>Roof Covering</td>
<td>116</td>
</tr>
<tr>
<td>12.</td>
<td>False Ceiling and Partitions</td>
<td>123</td>
</tr>
<tr>
<td>13.</td>
<td>Floor Finishes and Paving</td>
<td>1131</td>
</tr>
<tr>
<td>14.</td>
<td>Plastering and Pointing</td>
<td>1152</td>
</tr>
<tr>
<td>15.</td>
<td>White Wash, Colour Wash and Distempering</td>
<td>159</td>
</tr>
<tr>
<td>16.</td>
<td>Glazing</td>
<td>161</td>
</tr>
<tr>
<td>17.</td>
<td>Painting</td>
<td>163</td>
</tr>
<tr>
<td>18.</td>
<td>Water supply, Plumbing and Sanitary Works</td>
<td>173</td>
</tr>
<tr>
<td>19.</td>
<td>Road Works</td>
<td>199</td>
</tr>
<tr>
<td>20.</td>
<td>Clean room works</td>
<td>224</td>
</tr>
<tr>
<td>21.</td>
<td>Land Scaping &amp; Horticulture</td>
<td>2231</td>
</tr>
<tr>
<td>22.</td>
<td>List of Approved Materials</td>
<td>236</td>
</tr>
<tr>
<td>24.</td>
<td>List Of Mandatory Tests</td>
<td>238</td>
</tr>
<tr>
<td>25.</td>
<td>List Of Mandatory Field checks</td>
<td>243</td>
</tr>
</tbody>
</table>
**GENERAL RULES**

1.1 **Interpretation:**
The Engineer in-charge shall be the sole deciding authority as to the meaning, interpretation and implication of various provisions of the specifications. His decision in writing shall be final and binding on all concerned.

1.2 **Definitions:**
The following terms and expression in the specification shall have the meaning and implication hereby assigned to them unless mentioned otherwise elsewhere:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Best</td>
<td>With reference to quality of material and workmanship, the standard required shall be specified in preference to the expression “Best”. The word “Best” when used shall mean that, in the opinion of the EIC there is no superior material / article and workmanship obtainable in the market and trade respectively.</td>
</tr>
<tr>
<td>(b) Local</td>
<td>The word “Local” when used with reference to material / article shall mean the best (at the direction of EIC) of its kind available and used in the locality (i.e. within a distance of 40km from the boundary of the site of work, unless specified to the contrary in the tender Documents).</td>
</tr>
<tr>
<td>(c) Site</td>
<td>The land(s) and / or other place(s) on, in, into or through which work is to executed under the contract, or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the contract.</td>
</tr>
<tr>
<td>(d) Contractor</td>
<td>The individual or Firm or company whether incorporated or not, undertaking the works and shall include the legal representative of such individual or the person comprising such firm or company, or the successor of such individual or firm or company and the permitted assign of such individual or firm or company.</td>
</tr>
<tr>
<td>(e) Approved / Directed</td>
<td>The approval or direction of the EIC or person deputed by him for the particular purpose.</td>
</tr>
<tr>
<td>(f) Indicated / As Indicated</td>
<td>As shown in drawings, specified in the BOQ, Technical Specifications, and Contract Conditions or deviation orders.</td>
</tr>
<tr>
<td>(g) Specially Ordered</td>
<td>Separately ordered in writing for the particular item(s) only in addition to the usual works, Orders, Requisition, etc.</td>
</tr>
<tr>
<td>(h) IS</td>
<td>The specifications and codes of Practice issued by the Indian Standard Institution (BIS)</td>
</tr>
<tr>
<td>(i) Month</td>
<td>A calendar Month</td>
</tr>
<tr>
<td>(j) E.I.C</td>
<td>The Engineer- in -Charge appointed by HAL or his nominee(s) to supervise the works or part of the works.</td>
</tr>
</tbody>
</table>
1.3 **Abbreviation** - The following abbreviation, wherever they appear in the Specification shall have the meaning or implication hereby assigned to them:

1. Air Break A.B.
2. All-Aluminium Conductor A.A.C.
3. Alternating Current A.C. or AC
4. Aluminium Conductor Steel Reinforced A.C.S.R
5. Average avg
6. Bayonet Cap B.C.
7. Cab Tyre Sheathed C.T.S.
8. Centimetre cm
9. Cord Grip C.G.
10. Cubic cu
11. Cubic Centimetre Cm³/cu cm
12. Cubic Metre m³/cum
13. Degree Centigrade or Celsius Temperature °C
14. Diameter dia
15. Direct Current DC
16. Double Pole DP
17. Edison Screw ES
e etcetera etc.
19. exceeding exc.
20. Figure Fig.
21. for example e.g.
22. Goliath screw G.S.
23. gram g, gm
24. High Tension HT
25. Indian Army Form Works IAFW
26. Iron Clad C
27. Iron Clad Triple Pole ICTP
28. Kilogram kg
29. Kilolitre kl
30. Kilometer km
31. Kilovolts KV.
32. Kilovolt Amps KVA
33. Labour only L.O.
34. Litre l
35. Long Way Mesh LWM
36. Low Tension LT
37. Material and Labour M&L
38. Metre m
39. Milimetre mm
40. namely viz.
41. not exceeding n.exc.
42. number(s) No.
43. Paper Insulated Lead Covered PILC
44. Paper Insulated Lead Covered Armoured PILCA
45. Plain Cement Concrete PCC
46. Polyvinyl-Chloride PVC
47. Quintal q
48. Running Metre Rmt, RM
49. Reinforced Cement Concrete RCC
50. Rupee/Rupees Re/Rs
**14 Specification of materials -Indian Standard Specification:**

1.4.1 In the specification of materials which have been specified to conform to Indian standard have been partially reproduced from the relevant standard. These partial reproduction have been made to only indicate specific requirements where alternative choice are mentioned in the IS and to bring out some of the quality characteristics for ready reference. The specification in the relevant Standard shall however be followed unless it is specifically mentioned that a particular requirement of the Relevant Standard is dispensed with or is varied and the extent thereof is mentioned.

1.4.2 Where any IS referred to in the Specification is amended, or revised, superseded or is merged into another IS or if split into more than one standard, either the IS referred to in the specification or any of the subsequently amended / revised / superceded / merged / split / is as applicable may be followed as alternative specification. Where any particular alternative out of two or more alternatives given in an IS is adapted and this alternative also figures in the amended / revised / merged split up IS, the alternative specified in the specification shall be followed.

1.4.3 For a composite item consisting of several items, each item will follow the relevant specification for that item and each operation will be carried out as per the relevant specification for that part of the item.

**15 Materials to be approved**

1.5.1 All materials to be provided by the Contractors shall be brand new and in accordance with the specifications. Where specifications are not given, the materials shall confirm to the quality as approved by the EIC. Samples of materials, fittings etc., shall be submitted by the Contractor for the approval of EIC before bulk supplies are brought on the site of works. Cement, Reinforcement / Structural steel shall be from a reputed manufacturer and should confirm to the relevant IS Codes. The contractor shall provide purchase vouchers from the reputed manufacturers / Suppliers.

1.5.2 The contractor shall satisfy the EIC that the materials provided by him confirm to the requirement of the specifications and are as per the sample approved by the EIC. Where materials are specified to comply with the requirements of an IS Specifications, the Contractor shall if required, furnish the manufacturer's certificate that the materials satisfy the requirements of the IS.

1.5.3 The contractor shall supply samples of materials allowing ample time for the testing and approval in order that if the samples supplied fail to satisfy the specified requirements there will be time to receive and test other samples before materials are required to be used.

1.5.4 Materials rejected by the EIC shall be removed forthwith by the contractor off the premises.

**16 Testing of Materials**

1.6.1 Methods of Test - When required by the EIC, test on materials shall be carried out in accordance with standard methods of tests issued by the Indian Standards Institution. Laboratory tests shall be conducted by recognised laboratories acceptable to the EIC.

1.6.2 Samples of testing - The Contractor shall supply free of charge samples for testing of any material
proposed to be used in the works. All expenditure required to be incurred for taking the samples packaging, conveyance etc., shall be borne by the Contractor.

1.6.3 **Cost of Testing:** The cost of testing shall be borne by the contractor.

**1.7 Storage of Materials**

1.7.1 Materials shall be stored at site in such a way as to prevent deterioration or the loss or impairment of their structural and other essential properties. Materials which normally deteriorate during storage shall be kept constantly moving, by replacing old materials with fresh stocks. Freshly arrived shall never be placed over materials which had arrived earlier.

1.7.2 **Protection against Atmospheric Agencies**

Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric effects due to rain sun or wind or moisture to avoid deterioration.

1.7.3 **Protection against Fire and other Hazards**

Materials like Timber, Paints etc. shall be stored at site in such a way that there may not be any possibility of fire hazards. Inflammable materials and explosive shall be stored in accordance with the relevant regulation and rules so as to ensure the desired safety during storage.

**1.8 Unit weight of Building Materials**

The unit weight of materials, unless otherwise indicated in the relevant Indian Standards for the materials, shall be reckoned as given in IS 1911-1967 schedule of unit weight of Building materials.

**19 Workmanship-IS Codes of Practice and Safety Codes**

1.9.1 The work shall be carried out as described in the specification and IS codes of Practices and safety codes where referred to in the Specification and the provisions of the relevant IS code of Practice or Safety Code, Provision in the Specification shall take precedence.

1.9.2 Where IS Code of Practice and Safety Codes have not been referred to in the Specification, the relevant IS Standard may be followed as a guide for standard Practice.

**1.10 Methods of Construction, Tools and Plants.**

The contractor shall employ only such methods of construction, tools and plant as are appropriate for the type of work.

**1.11 Water**

Water used whether in the process of making materials or in the execution of the work or for cleaning, etc. shall be clean and fresh, and free from deleterious matter and shall be obtained from an approved source.

**1.12 Directions**

Instructions shall be given in writing for all approved directions; no verbal instruction shall be deemed to be binding nor shall such work be measured/paid.

**1.13 Alternatives**

Where alternatives materials, process, etc. are specified in the specification, the discretion shall rest with the EIC.

**1.14 Safety in Construction**

The contractor shall take all necessary precaution and measures listed in the IS Safety Codes, in the MES Safety Code or as directed by the EIC to ensure the safety of works/construction and of workmen and shall be responsible for the same. The provision of the following IS Safety Codes shall generally apply.
1.14FIELD LABORATORY

1.14.01 An adequately equipped field laboratory as required for site control on the quality of materials and the works shall be provided and maintained by the Contractor till the completion of works. The rates quoted for all the items of work shall include for the provision and maintenance of field laboratory.

1.14.02 Description

The Contractor shall arrange to provide fully furnished and adequately equipped field laboratory constructed considering the space required for housing the required equipment. The field laboratory shall preferably be located adjacent to the site office of the Engineer in charge and provided with amenities like water supply, electric supply etc.

The floor space requirement for the field laboratory shall be adequate and as directed. It shall include office for Lab In charge, space for the Materials, Engineers one from the Contractor’s side and another from the Consultant side and a store for the storage of samples. The remaining space shall be provided for the installation of equipment, laboratory tables and cupboards, working space for carrying out various laboratory tests, besides a wash basin, toilet facility and a curing tank for the curing of samples, around 4 m x 2 m x 1 m in size and a fume chamber. The furnishing of the office and laboratory shall be provided to the requirements. Wooden / concrete working table with a working platform area of about 1 m x 10 m shall be provided against the walls, also providing wooden cupboards above and below the working tables to store accessories such as sample moulds etc. At least 4 racks of slotted angles and M.S sheets and atleast 6 stools for laboratory test operators shall also be provided.

1.14.03 Laboratory Equipment

The following items of laboratory equipment shall be provided in the field laboratory.

i. Oven -Electrically operated, thermostatically controlled, range upto 200° C sensitivity 1°C 1 No

ii. Platform balance 300 Kg. capacity 1 No.

iii. Balance 20 Kg. capacity-self indicating type 1 No

iv. Electronic Balance 5 Kg capacity accuracy 0.5 gm 2 Nos

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>3696 (Part 1)-1 987</td>
<td>Safety Code for scaffolds and ladders -Part I, Scaffolds</td>
</tr>
<tr>
<td>3696 (Part 1-1)-1966</td>
<td>Ditto-Part II, Ladders</td>
</tr>
<tr>
<td>4014 (part 11)-1967</td>
<td>Code for Practice for steel tubular scaffolding; Part II, safety regulation scaffolding</td>
</tr>
<tr>
<td>4130-1976</td>
<td>Safety Code for demolition of buildings (first revision)</td>
</tr>
<tr>
<td>5121-1969</td>
<td>Safety Code for piling and other deep foundation</td>
</tr>
<tr>
<td>7969-1975</td>
<td>Safety Code for storage and handling of building materials</td>
</tr>
</tbody>
</table>
v. Water bath electrically operated and thermostatically controlled with adjustable shelves, sensitivity 1°C 1 No.

vi. Thermometers
- Mercury-in-glass thermometer range 0° to 250°C 4 Nos
- Mercury-in-steel thermometer with 30 cm stem, range up to 300°C

vii. Kerosene or gas stove or electric hot plate 1 No.

viii. Glassware's, spatulas, wire gauzes, steel scales, measuring tape, casseroles, As required karahis, enamelled trays of assorted sizes, pestle-mortar, porcelain dishes, gunny bags, plastic bags, chemicals, digging tools, like pickaxes, shovels etc.

ix. Set of IS sieves with lid and pan: 450 mm diameter 1 Set
- 63 mm, 53 mm, 37.5 mm, 26.5 mm, 13.2 mm, 9.5 mm, 6.7 mm, 4.75 mm size 2 Sets
- 2.36 mm, 2.0 mm, 1.18 mm, 600 micron, 425 micron, 300 micron, 150 micron diameter and 75 micron
- Water testing kit 1 Set
- First aid box 1 Set
- Digital caliper 2 Nos
- Digital Vernier/Screw gauge 2 Nos each
- Measuring tapes, 3.00 Mtr, 5.00 Mtr, 30 Mtrs 3 Nos each

For soils and aggregates

i. Riffle Box 1 No.

ii. Atterberg Limits (liquid and plastic limits) determination apparatus

iii. Compaction Test Equipment both 2.5 Kg and 4.5 Kg rammers (Light and Heavy compactive efforts) 1 Set

iv. Dry Bulk Density Test apparatus (sand pouring cylinder, tray can etc.) complete

v. Speedy Moisture Meter complete with chemicals 1 Set

vi. Post-hole Auger with extensions 1 Set

vii. Core cutter apparatus 10 cm dia 10/15 cm height, complete with dolly, rammer etc

viii. Aggregate Impact Value Test apparatus / Los Angles Abrasion Test apparatus

ix. Flakiness and Elongation Test Gauges 1 Set

Standard measures of 30, 15 and 3 liters capacity along with standard tamping rod 1 Set

x. California Bearing Ratio test apparatus 1 Set

xi. Unconfined compression test apparatus’ For bitumen and bituminous mixes 1 Set

For bitumen and bituminous mixes

i. Penetrometer with standard needles 1 Set

ii. Riffle box - small size 1 Set

iii. Centrifuge type bitumen extractor, hand operated, complete with petrol / commercial benzenes 1 No

iv. Marshall stability test apparatus, complete with all accessories' 1 Set

v. Field density bottle along with cutting tray, chisel, hammer and standard sand 1 Set

vi. 3 m straight edge 2 Nos
vi. Camber board 1 No
vii. Core cutting machine with 10-cm dia diamond cutting edge 1 No
ix. Vacuum pump and 3 specific gravity 1 Set

For cement and cement concrete
i. Vicat apparatus for testing setting times 1 Set
ii. Slump testing apparatus 4 Sets
iii. Compression and Flexural strength testing machine of 200 tonne capacity with additional dial for flexural testing 1 No.
iv. Needle Vibrator 2 Nos
v. Air Meter 1 No.
vi. Vibrating hammer for vibrating dry mix as for Dry Lean 1 No.
vii. Cement concrete sub base

Note: The items and their numbers listed above in this Clause shall be decided by the Engineer as per requirements of the Project and modified accordingly. In addition any other equipment/tools found required for field test, the same shall be provided by the contractor as per the direction of consultant and Engineer – in-charge.

1.14.04 Maintenance

The Contractor shall arrange to maintain the field laboratory in a satisfactory manner until the issue of Taking over Certificate for the complete work.

1.15 Method of Measurement:

For method of measurement MES SSR and I.S-1200, Specification for Method of measurement of Building and Civil Engineering Works shall be followed.

1.16 Theoretical Consumption of Materials:

For theoretical consumption of materials like cement aggregates, etc., IS 10067, Specification for material constants and Building works shall be followed.
LIST OF INDIAN STANDARDS

The below given list is only indicative. Following is the consolidated list of Indian Standards referred to under the respective section in these specifications. In case any IS Code is not referred to here the code applicable to the said material/workmanship shall apply irrespective of that indicated in the Technical Specification or not.

<table>
<thead>
<tr>
<th>IS Code.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>5- 2004</td>
<td>Colours for ready mixed paint and enamels (Fifth revision)</td>
</tr>
<tr>
<td>44- 1991</td>
<td>Specification for Iron oxide pigments for paints (Second revision)</td>
</tr>
<tr>
<td>63- 1978</td>
<td>Specification for whitening for paints and putty (Third revision)</td>
</tr>
<tr>
<td>104- 1979</td>
<td>Ready mixed paint, brushing, zinc chrome, priming (Second revision)</td>
</tr>
<tr>
<td>109 - 1968</td>
<td>Ready mixed paint, brushing, priming, plaster to IS Colour No 361, Light stone and No 631 Light grey (First revision)</td>
</tr>
<tr>
<td>110 - 1983</td>
<td>Ready mixed point, brushing, grey filler, for enamels for use over primers</td>
</tr>
<tr>
<td>157 - 1950</td>
<td>Ready mixed paint, brushing, acid and alkali resistant, lead free, for general purposes, to IS Colour No 446 red oxide, No 537, Signal red No 632 Dark admiralty grey and black and other colours as required</td>
</tr>
<tr>
<td>158 - 1981</td>
<td>Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting (Third revision)</td>
</tr>
<tr>
<td>159 - 1981</td>
<td>Ready mixed paint, brushing, acid resisting for protection against acid fumes (First revision)</td>
</tr>
<tr>
<td>162-1950</td>
<td>Ready mixed paint, brushing, fire resisting, silicate type for use on wood colour as required.</td>
</tr>
<tr>
<td>164-1981</td>
<td>Ready mixed paint, brushing, for road marking for protection against Acid fumes. (First revision)</td>
</tr>
<tr>
<td>195- 2005</td>
<td>Fireclay Mortar for Laying Fireclay Refractory Bricks – Specification (Fourth Revision)</td>
</tr>
<tr>
<td>204- (Part 1)-1 991</td>
<td>Specification for tower bolts, Part 1, Ferrous metals, (Fifth revision)</td>
</tr>
<tr>
<td>204- (Part 2)-1992</td>
<td>Specification for tower bolts, Part 2, Non ferrous metals, (Fifth revision)</td>
</tr>
<tr>
<td>207 - 1964</td>
<td>Specification for gate and shutter hooks and eyes (First revision)</td>
</tr>
<tr>
<td>208 - 1996</td>
<td>Specification for door handles (Fifth revision)</td>
</tr>
<tr>
<td>210- 1993</td>
<td>Specification for Grey Iron casting (Fourth revision)</td>
</tr>
<tr>
<td>212-1983</td>
<td>Specification for Crude coal tar for general use (Second revision)</td>
</tr>
<tr>
<td>217-1988</td>
<td>Specification for cut back bitumen (Second Revision)</td>
</tr>
<tr>
<td>218-1983</td>
<td>Specification for Creosote and anthracite oil for use as wood preservative(Second revision)</td>
</tr>
<tr>
<td>261- 1982</td>
<td>Specification for copper sulphate (Second revision)</td>
</tr>
<tr>
<td>277- 2003</td>
<td>Specification for Galvanised Steel sheet (plain and corrugated)(Sixth revision)</td>
</tr>
<tr>
<td>No.</td>
<td>Year</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>278-2001</td>
<td>Specification for Galvanised Steel Barbed wire for fencing (Third revision)</td>
</tr>
<tr>
<td>280-2006</td>
<td>Specification for mild steel wire for general engineering purposes (Fourth revision)</td>
</tr>
<tr>
<td>281-1991</td>
<td>Specification for mild steel sliding door bolts for use with pad-locks (Third revision)</td>
</tr>
<tr>
<td>287-1993</td>
<td>Recommendation for maximum permissible moisture content of Timber used for different purposes (Third revision)</td>
</tr>
<tr>
<td>303-1989</td>
<td>Specification for plywood for general purposes (Third revision)</td>
</tr>
<tr>
<td>335-1993</td>
<td>New insulating oil for transformers and switchgear (Third revision)</td>
</tr>
<tr>
<td>341-1973</td>
<td>Black Japan, type A, B and C (First revision)</td>
</tr>
<tr>
<td>345-1952</td>
<td>Wood filler, transparent liquid</td>
</tr>
<tr>
<td>349-1981</td>
<td>Lacquer, cellulose, nitrate, clear, finishing glossy for metal (First revision)</td>
</tr>
<tr>
<td>362-1991</td>
<td>Specification for parliament hinges (Fifth revision)</td>
</tr>
<tr>
<td>363-1993</td>
<td>Specification for hasps and staples (Fourth revision)</td>
</tr>
<tr>
<td>373-1975</td>
<td>Specification for plywood for general purposes (Second revision)</td>
</tr>
<tr>
<td>383-1970</td>
<td>Specification for coarse and fine aggregates from natural sources for concrete (Second Revision)</td>
</tr>
<tr>
<td>398-(Part 1) 1976</td>
<td>Aluminium conductors for overhead transmission purposes. Part: 1 Aluminium stranded conductors (Third revision)</td>
</tr>
<tr>
<td>398-(Part 2) 1976</td>
<td>Aluminium conductors for overhead transmission purposes. Part: 2 Aluminium conductors, alvanized seel reinforced (Third revision)</td>
</tr>
<tr>
<td>401-2001</td>
<td>Code of practice for preservation of timber (Fourth revision)</td>
</tr>
<tr>
<td>412-1975</td>
<td>Specification for expanded metal steel sheets for general purposes (Second revision)</td>
</tr>
<tr>
<td>419-1967</td>
<td>Specification for putty for use on window frames (First revision)</td>
</tr>
<tr>
<td>423-1961</td>
<td>Plastic wood for joiner’s filler (Revised)</td>
</tr>
<tr>
<td>426-1961</td>
<td>Paste filler for colour coats</td>
</tr>
<tr>
<td>427-2000</td>
<td>Specification for distemper dry, colour as required (Second revision)</td>
</tr>
<tr>
<td>428-2000</td>
<td>Specification for washable distemper (Second revision)</td>
</tr>
<tr>
<td>430-1972</td>
<td>Paint remover, solvent type, non flammable (Second revision)</td>
</tr>
<tr>
<td>431-1972</td>
<td>Paint remover, solvent type, flammable (Second revision)</td>
</tr>
<tr>
<td>432- (Part I) 1982</td>
<td>Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement, Part I, Mild steel and medium tensile steel bars (Third revision)</td>
</tr>
<tr>
<td>432- (Part 2) 1982</td>
<td>Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-II, Hard drawn steel wire (Third revision)</td>
</tr>
<tr>
<td>444-1987</td>
<td>General purposes rubber water hose (Fourth revision)</td>
</tr>
<tr>
<td>451-1999</td>
<td>Technical supply conditions for wood-screws (Third revision)</td>
</tr>
<tr>
<td>452-1993</td>
<td>Specification for door springs rat-tail type (Second revision)</td>
</tr>
<tr>
<td>453-1993</td>
<td>Specification for double acting spring hinges (Third revision)</td>
</tr>
<tr>
<td>454-1994</td>
<td>Specification for Digboi type cut back bitumen (Second revision)</td>
</tr>
<tr>
<td>455-1989</td>
<td>Specification for Portland Slag Cement (Fourth Revision)</td>
</tr>
<tr>
<td>No.</td>
<td>Title</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>456</td>
<td>Plain and Reinforced Concrete – Code of Practice (Third Revision)</td>
</tr>
<tr>
<td>458</td>
<td>Specification for concrete pipes with or without reinforcement. (Fourth revision)</td>
</tr>
<tr>
<td>459</td>
<td>Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets (Third revision)</td>
</tr>
<tr>
<td>460</td>
<td>Test Sieves : Part I Wire cloth test sieves (Third Revision)</td>
</tr>
<tr>
<td>460</td>
<td>Test Sieves : Part II Perforated plate test sieves (Third Revision)</td>
</tr>
<tr>
<td>460</td>
<td>Test Sieves : Part III Methods of examination apertures of test Sieves of (Third Revision)</td>
</tr>
<tr>
<td>516</td>
<td>Method of test for Strength of concrete.</td>
</tr>
<tr>
<td>524</td>
<td>Varnish, finishing, exterior synthetic air drying (Second revision)</td>
</tr>
<tr>
<td>650</td>
<td>Specification for Standard sand for testing of cement.</td>
</tr>
<tr>
<td>653</td>
<td>Specification for linoleum sheets and tiles.</td>
</tr>
<tr>
<td>655</td>
<td>Specification for Metal Air ducts (Second revision)</td>
</tr>
<tr>
<td>659</td>
<td>Safety code for Air Conditioning (Revised)</td>
</tr>
<tr>
<td>660</td>
<td>Safety code for Mechanical Refrigeration (Revised)</td>
</tr>
<tr>
<td>661</td>
<td>Code of practice for thermal insulation of cold storage (Third revision)</td>
</tr>
<tr>
<td>692</td>
<td>Paper insulated lead sheathed cable for electricity supply (Third Revision)</td>
</tr>
<tr>
<td>694</td>
<td>PVC insulated cables for working voltages upto and including 1100 volts (Third revision)</td>
</tr>
<tr>
<td>707</td>
<td>Glossary of terms applicable to timber technology and utilization (Second revision)</td>
</tr>
<tr>
<td>723</td>
<td>Specification for steel countersunk head wire nails (First revision)</td>
</tr>
<tr>
<td>731</td>
<td>Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 volts (Second revision)</td>
</tr>
<tr>
<td>732</td>
<td>Code of Practice for electrical wiring installations. (Third revision)</td>
</tr>
<tr>
<td>733</td>
<td>Specification for wrought aluminium and aluminium alloys bars, rods and sections (for general engineering purposes). (Third revision)</td>
</tr>
<tr>
<td>737</td>
<td>Specification for wrought aluminium and aluminium alloys sheets and strip for general engineering purposes (Third revision)</td>
</tr>
<tr>
<td>749</td>
<td>Specification for handloom cotton dungri cloth (First revision).</td>
</tr>
<tr>
<td>774</td>
<td>Specification for flushing cistern for water closets and urinals (other than plastic cistern) (Fifth revision).</td>
</tr>
<tr>
<td>775</td>
<td>Specification for cast iron brackets and supports for wash basins and sinks (Second revision).</td>
</tr>
<tr>
<td>778</td>
<td>Specification for Gun Metal Gate, Globe and Check valves for general purposes (Fourth revision)</td>
</tr>
<tr>
<td>781</td>
<td>Specification for cast copper alloy, screw down, bib taps and stop valves for water services (Third revision)</td>
</tr>
<tr>
<td>782</td>
<td>Specification for caulking lead (Third revision)</td>
</tr>
<tr>
<td>800</td>
<td>Code of practice for general construction in steel (Second revision).</td>
</tr>
<tr>
<td>807</td>
<td>Design, Erection and testing (Structural Portion) of Cranes and Hoists – Code of Practice (Second revision)</td>
</tr>
<tr>
<td>808</td>
<td>Dimensions for hot rolled steel beam, column, channel and angle sections. (Third revision)</td>
</tr>
<tr>
<td>811</td>
<td>Cold formed light gauge structural steel section. (Revised)</td>
</tr>
<tr>
<td>814</td>
<td>Specification for covered electrodes for manual metal arc welding of</td>
</tr>
</tbody>
</table>
carbon and carbon manganese steel (sixth revision)


818- 1968  Code of practice for safety and health requirement in electric and gas welding and cutting operations (First Revision)


848- 2006  Specification for synthetic resin adhesive for plywood (phenolic and amino plaster) (Second revision)

8 5 1 - 1978  Specification for synthetic resin adhesive for construction work (non structural) in wood (First revision)

8 5 2 - 1994  Specification for animal glue for general wood working purposes (Second revision)

1019-1974  Specification for rim latches (Second revision).

1038-1983  Specification for steel doors, windows and ventilators (Third revision)

1077-1992  Common Burnt Clay Building Bricks – Specification (Fifth Revision)

1081- 1960  Code of practice for fixing and glazing of metals (steel and aluminium) doors, windows and ventilators.


1122- 1974  Methods of test for determination of specific gravity of natural building stones (First Revision)

1123-1975  Methods of identification of natural building stones (First Revision)

1124- 1974  Method of Test for Determination of Water Absorption, Apparent Specific Gravity and Porosity of Natural Building Stones (First Revision)

1125-1974  Methods of test for determination of weathering of natural building stones (First Revision)

1126- 1974  Methods of test for determination of durability of natural building stones (First Revision)

1128- 1974  Specification for Lime Stones (Slab & Tiles) (First Revision)

1129- 1972  Recommendations for Dressing of Natural Building Stones (First Revision)

1141-1993  Specification for code of practice for seasoning of timber (Second Revision)

1148- 1982  Specification for hot rolled rivet bars (up to 40mm diameter) for structural purposes (Third revision).

1173-1978  Hot rolled slit steel tee bars (Second revision)

1199-1959  Method of Sampling and Analysis of Concrete.

1200  Method of Measurement

1239-(Part I) 2004  Specification for mild steel tubes, tubulars and other wrought steel fittings (Part I): Mild steel tubes (Sixth revision).

1239-(Part 2) -1992  MS tubes, tubular and other wrought steel fittings, Part 2 MS tubular and other wrought steel pipe fitting (Fourth revision)

1252- 1991  Dimension of Hot rolled steel bulb angles (First revision)

1255-1983  Code of Practice for installation and maintenance of paper insulated power cables.(upto and including 33 KV) (Second revision).

1258-2005  Bayonet lamp holders (Fourth revision).

1284- 1975  Wrought aluminium alloy bolt and screw stock for general engineering purposes (Second Revision)

1285-2002  Specification for wrought aluminium and aluminium alloys extruded round tube and hollow sections for general engineering purposes (Third revision)

1293-2005  Specification for plugs and sockets out let of rated voltage upto and including 250 Volts and rates current upto and including 16 Amperes (Third revision).

1341- 1992  Specification for steel butt hinges (Sixth revision).

1361- 1978  Specification for steel windows for industrial buildings (First revision)

1363-2002(Part 1 )  Hexagon head bolts, screw and nuts of product grade ‘C- Part-I, Hexagon head bolts (Size range M 5 to M 64) (Fourth revision)

1363- 2002( Part 2 )  Hexagon head bolts, screw and nuts of product grade ‘C- Part-II, Hexagon head screws (Size range M 5 to M 64) (Fourth revision)
<table>
<thead>
<tr>
<th>Volume</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1 to 20</td>
<td>Technical supply conditions for threaded fasteners</td>
</tr>
<tr>
<td>1464-1992</td>
<td>Specification for clay ridge and ceiling tiles (Second revision)</td>
</tr>
<tr>
<td>1520-1961</td>
<td>Horizontal centrifugal pumps for cold, clear and fresh water (Second revision)</td>
</tr>
<tr>
<td>1536-2001</td>
<td>Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage (Fourth revision)</td>
</tr>
<tr>
<td>1537-1976</td>
<td>Specification for vertically cast iron pressure pipes for water, gas and sewage (First revision)</td>
</tr>
<tr>
<td>1538-1993</td>
<td>Specification for cast iron fittings for pressure pipes for water, gas and sewage (First revision)</td>
</tr>
<tr>
<td>1542-1992</td>
<td>Specification for sand for plaster (Second revision)</td>
</tr>
<tr>
<td>1566-1982</td>
<td>Specification for hard drawn steel wire fabric for concrete reinforcement (Second revision)</td>
</tr>
<tr>
<td>1568-1970</td>
<td>Specification for wire cloth for general purposes (First revision)</td>
</tr>
<tr>
<td>1580-1991</td>
<td>Specification for bituminous compound for waterproofing and caulking purposes (Second revision)</td>
</tr>
<tr>
<td>1596-1977</td>
<td>Polyethylene insulated cables for working voltages upto and including 1100 volts (Second revision)</td>
</tr>
<tr>
<td>1646-1997</td>
<td>Code of practice for fire safety of buildings (general) Electrical installations (Second revision)</td>
</tr>
<tr>
<td>1658-2006</td>
<td>Specification for fibre hardboards (Third Revision)</td>
</tr>
<tr>
<td>1659-2004</td>
<td>Specification for block boards (Third revision)</td>
</tr>
<tr>
<td>1678-1998</td>
<td>Specification for Pre-stressed concrete poles for overhead power, traction and telecommunication lines (Second revision)</td>
</tr>
<tr>
<td>1703-2000</td>
<td>Specification for water fittings - copper alloy float valves (Horizontal plunger type (Fourth revision)</td>
</tr>
<tr>
<td>1706-1972</td>
<td>Method for Determination of Resistance to Wear by Abrasion of Natural Building Stones (First Revision)</td>
</tr>
<tr>
<td>1708-(Part 1 to 18)-1986</td>
<td>Method of testing of small clear specimen of timber (Second Revision)</td>
</tr>
<tr>
<td>1711-1984</td>
<td>Specification for self-closing taps for water supply purposes (Second revision)</td>
</tr>
<tr>
<td>1726-1991</td>
<td>Specification for cast iron manhole covers and frames. (Third revision)</td>
</tr>
<tr>
<td>1729-2002</td>
<td>Cast iron/ ductile iron drainage pipe and pipe fittings for over ground Non Pressure pipe lines socket and spigot service (Second revision)</td>
</tr>
<tr>
<td>1730-1989</td>
<td>Dimensions for steel plates, sheets, strips and flats for general engineering purposes-(Second revision)</td>
</tr>
<tr>
<td>1732-1989</td>
<td>Dimensions for round and square steel bars for structural and general engineering purposes. (Second revision)</td>
</tr>
<tr>
<td>1734-(Part 1 to 20)</td>
<td>Method of test for plywood (Part 1 to 20 in one volume (Second 1993 Revision)</td>
</tr>
<tr>
<td>1777-1978</td>
<td>Industrial luminaire with metal reflectors (First revision)</td>
</tr>
<tr>
<td>1786-1985</td>
<td>Specification high strength deformed steel bars and wires for concrete reinforcement (Third revision)</td>
</tr>
<tr>
<td>1795-1982</td>
<td>Specification for pillar taps for water supply purposes (Second revision)</td>
</tr>
<tr>
<td>1805-1973</td>
<td>Glossary of terms relating to stones, quarrying and dressing (First Revision)</td>
</tr>
<tr>
<td>1823-1980</td>
<td>Specification for floor door stoppers (Third revision)</td>
</tr>
<tr>
<td>1834-1984</td>
<td>Specification for hot applied sealing compound for joints in the concrete (First revision)</td>
</tr>
<tr>
<td>1838-(Part 1) 1983</td>
<td>Specification for preformed filler for expansion joints in concrete, nonextending and resilient type (Bitumen impregnated fibre) (First revision)</td>
</tr>
<tr>
<td>1852-1985</td>
<td>Rolling and cutting tolerances for hot rolled steel products (Fourth revision)</td>
</tr>
<tr>
<td>1863-1979</td>
<td>Hot rolled steel bulb flats (First revision)</td>
</tr>
<tr>
<td>Code/Year</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1866-2000</td>
<td>Code of Practice for maintenance and supervision of mineral insulating oil in service equipment (Third revision).</td>
</tr>
<tr>
<td>1868- 1996</td>
<td>Specification for anodic coating on aluminium and its alloys (Third revision)</td>
</tr>
<tr>
<td>1879-1987</td>
<td>Specification for malleable cast iron pipe fittings (Second revision).</td>
</tr>
<tr>
<td>1905- 1987</td>
<td>Code of Practice for Structural Use of Un-reinforced Masonry (Third Revision)</td>
</tr>
<tr>
<td>1948- 1961</td>
<td>Specification for aluminium doors, windows and ventilators</td>
</tr>
<tr>
<td>1949- 1961</td>
<td>Specification for aluminium windows for industrial buildings</td>
</tr>
<tr>
<td>2016- 1967</td>
<td>Specification for plain washers (First revision).</td>
</tr>
<tr>
<td>2046- 1995</td>
<td>Specification for decorative thermosetting synthetic resin bonded laminated sheets (First revision).</td>
</tr>
<tr>
<td>2062- 2006</td>
<td>Specification for hot rolled low, medium and high tensile structural steel (Sixth revision)</td>
</tr>
<tr>
<td>2074-1992</td>
<td>Specification for Ready mixed paint, air drying, red oxide zinc chrome priming (Second revision)</td>
</tr>
<tr>
<td>2116- 1980</td>
<td>Specification for Sand for Masonry Mortars (First Revision)</td>
</tr>
<tr>
<td>2141-2000</td>
<td>Hot dip Galvanised stay strand (Fourth revision).</td>
</tr>
<tr>
<td>2202- (Part 1)- 1999</td>
<td>Specification for wooden flush door shutters (solid core type), Part I plywood face panels (Sixth Revision)</td>
</tr>
<tr>
<td>2202- (Part 2)- 1983</td>
<td>Specification for wooden flush door shutters (solid core type) Part 2 Particle board face panels and hard board face panels (Third revision)</td>
</tr>
<tr>
<td>2326-1987</td>
<td>Specification for automatic flushing cisterns for urinals (other than plastic cistern) (Second revision).</td>
</tr>
<tr>
<td>2366- 1983</td>
<td>Code of Practice for nails jointed timber construction (First revision)</td>
</tr>
<tr>
<td>2379-1990</td>
<td>Colour code for indentification of pipe lines (First revision)</td>
</tr>
<tr>
<td>2386-(Part-1) 1963</td>
<td>Methods of test for aggregate for concrete Part 1 particle size and shape.</td>
</tr>
<tr>
<td>2386-(Part-3) 1963</td>
<td>Methods of test for aggregate for concrete Part 3 Specific gravity, density, voids, absorption and bulking.</td>
</tr>
<tr>
<td>2386-(Part-4) 1963</td>
<td>Methods of test for aggregate for concrete Part 4 Mechanical properties.</td>
</tr>
<tr>
<td>2506-1985</td>
<td>General requirement for Concrete Vibrates, Screed Board Type (First revision).</td>
</tr>
<tr>
<td>2551-1982</td>
<td>Danger notice plates (First revision).</td>
</tr>
<tr>
<td>2556-(Part 2) 2004</td>
<td>Specification for Vitreous Sanitary Appliances (Vitreous China) Part 2: Specific requirements of wash down water closets (Fourth revision)</td>
</tr>
<tr>
<td>2556-(Part 3) 2004</td>
<td>Specification for Vitreous Sanitary Appliances (Vitreous China) Part 3: Specific requirements of squatting pans (Fourth revision)</td>
</tr>
<tr>
<td>2556-(Part 4) 2004</td>
<td>Specification for Vitreous Sanitary Appliances (Vitreous China) Part 4: Specific requirements of wash basins. (Third revision)</td>
</tr>
<tr>
<td>Specification Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>2556-(Part 5) 1994</td>
<td>Specification for Vitreous Sanitary Appliances (Vitreous China) Part 5: Specific requirements of laboratory sinks. (Third revision)</td>
</tr>
<tr>
<td>2556-(Part 7) 1995</td>
<td>Specification for Vitreous Sanitary Appliances (Vitreous China) Part 7: Specific requirements of accessories for sanitary appliances (Third revision)</td>
</tr>
<tr>
<td>2645-2003</td>
<td>Specification for Integral Cement Waterproofing Compounds (Second Revision)</td>
</tr>
<tr>
<td>2681-1993</td>
<td>Specification for non-ferrous metal sliding door bolts (Aldrops) for use with padlocks (Third revision).</td>
</tr>
<tr>
<td>2686-1977</td>
<td>Specification for Cinder as fine Aggregate for use in Lime concrete (First Revision)</td>
</tr>
<tr>
<td>2691-1988</td>
<td>Specification for Burnt Clay Facing Bricks (Second Revision)</td>
</tr>
<tr>
<td>2700-1987</td>
<td>Code of Practice for roofing with wooden shingle (First revision)</td>
</tr>
<tr>
<td>2720-(Part-5) 1985</td>
<td>Methods of test for soils, Part 5 determination of liquid and plastic limit, (Second Revision)</td>
</tr>
<tr>
<td>2720-(Part-7) 1980</td>
<td>Methods of test for soils, Part 7 determination of water content dry density relation using light compaction (Second Revision).</td>
</tr>
<tr>
<td>2720:-Part 8: 1983</td>
<td>Method of Test for soils Part 8: Determination of Water Content-Dry Density Relation using heavy compaction (Second revision)</td>
</tr>
<tr>
<td>2720-(Part-28) 1974</td>
<td>Methods of test for soils, Part 28 determination of dry density of soils in place, by sand replacement methods (First Revision).</td>
</tr>
<tr>
<td>2750-1964</td>
<td>Specifications for steel scaffolding</td>
</tr>
<tr>
<td>2751-1979</td>
<td>Code of practice for welding of mild steel bars used for reinforced concrete construction (First revision).</td>
</tr>
<tr>
<td>2932-2003</td>
<td>Specification for Enamel, synthetic, exterior, under coating and finishing (Third revision)</td>
</tr>
<tr>
<td>2963-1979</td>
<td>Specification for copper alloy waste fittings for wash basins and sinks (First revision).</td>
</tr>
<tr>
<td>3016-1982</td>
<td>Code of practice for fire precautions in welding and cutting operations(First revision)</td>
</tr>
<tr>
<td>3034-1993</td>
<td>Code of Practice for fire safety of industrial buildings-Electrical generating and distribution stations. (Second revision)</td>
</tr>
<tr>
<td>3043-1987</td>
<td>Code of practice for earthing (First revision).</td>
</tr>
<tr>
<td>3063-1994</td>
<td>Specification for single coil rectangular section spring lock washers. (Second revision)</td>
</tr>
<tr>
<td>3068-1986</td>
<td>Specification for Broken Brick (burnt clay) Coarse Aggregate for Use in Lime Concrete (Second Revision)</td>
</tr>
<tr>
<td>Specification No.</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>3076-1985</td>
<td>Specification for low density polyethylene pipes for potable water supply (Second revision).</td>
</tr>
<tr>
<td>3087-2005</td>
<td>Specification for wood particle boards of wood and other lignocellulosic material (medium density) for general purposes (Second revision).</td>
</tr>
<tr>
<td>3097-2006</td>
<td>Specification for veneered particle boards (Second revision)</td>
</tr>
<tr>
<td>3103-1975</td>
<td>Code of practice for industrial ventilation (First revision)</td>
</tr>
<tr>
<td>3114-1994</td>
<td>Code of practice for laying of CI pipes (Second revision)</td>
</tr>
<tr>
<td>3129-1985</td>
<td>Specification for Low density particle Board (First revision)</td>
</tr>
<tr>
<td>3144-1992</td>
<td>Mineral wool thermal insulation - methods of tests (Second revision)</td>
</tr>
<tr>
<td>3177-1999</td>
<td>Code of Practice for Electric Overhead Travelling Cranes and Gantry Cranes other than Steel Work Cranes (Second revision)</td>
</tr>
<tr>
<td>3188-1980</td>
<td>Characteristics of string insulators (First revision).</td>
</tr>
<tr>
<td>3287-1965</td>
<td>Industrial lighting fittings with plastic reflectors.</td>
</tr>
<tr>
<td>3311-1979</td>
<td>Specification for waste plug and its accessories for sinks and wash basins (First revision).</td>
</tr>
<tr>
<td>3323-1980</td>
<td>Bi-pin lamp holders for tubular fluorescent lamps (First revision).</td>
</tr>
<tr>
<td>3324-1982</td>
<td>Holders for starters for tubular fluorescent lamps (First revision).</td>
</tr>
<tr>
<td>3337-1978</td>
<td>Specification for Bailies for general purpose (First revision)</td>
</tr>
<tr>
<td>3346-1980</td>
<td>Method for determination of thermal conductivity of insulation material (First revision)</td>
</tr>
<tr>
<td>3348-1965</td>
<td>Specification for fibre insulation boards.</td>
</tr>
<tr>
<td>3419-1988</td>
<td>Fittings for rigid non-metallic conduits (Second revision).</td>
</tr>
<tr>
<td>3443-1980</td>
<td>Crane rail sections (First revision)</td>
</tr>
<tr>
<td>3461-1980</td>
<td>Specification for PVC asbestos floor tiles. (First revision)</td>
</tr>
<tr>
<td>3462-1986</td>
<td>Specification for unbacked flexible PVC flooring (Second revision).</td>
</tr>
<tr>
<td>3502-1994</td>
<td>Specification for steel chequered plates (Second revision)</td>
</tr>
<tr>
<td>3536-1999</td>
<td>Specification for Ready mixed paint, brushing, wood primer, pink (First revision)</td>
</tr>
<tr>
<td>3553-1966</td>
<td>Watertight electric lighting fittings.</td>
</tr>
<tr>
<td>3564-1996</td>
<td>Specification for door closers hydraulically regulated (Fourth revision).</td>
</tr>
<tr>
<td>3585-1966</td>
<td>Ready mixed paint, aluminium, brushing, priming, water resistant for wood.</td>
</tr>
<tr>
<td>3588-1987</td>
<td>Specification for Electrical axial flow fans (First revision)</td>
</tr>
<tr>
<td>3589-2001</td>
<td>Specification for Electrically welded steel pipes for water, gas and sewage (Third revision)</td>
</tr>
<tr>
<td>3615-1967</td>
<td>Glossary of terms used in Refrigeration and Air Conditioning</td>
</tr>
<tr>
<td>3620-1979</td>
<td>Specification for Laterite stone block for masonry (First Revision)</td>
</tr>
<tr>
<td>3622-1977</td>
<td>Specification for Sand Stone (Slab &amp; Tiles) (First Revision)</td>
</tr>
<tr>
<td>3624-1987</td>
<td>Specification for pressure and vacuum gauges (Second revision)</td>
</tr>
<tr>
<td>3639-1966</td>
<td>Specification for Fittings and accessories for power transformers.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3676-1966</td>
<td>Ready mixed paint, thick white, for lettering</td>
</tr>
<tr>
<td>3764- 1992</td>
<td>Excavation work - Safety code (First revision).</td>
</tr>
<tr>
<td>3792-1978</td>
<td>Guide for heat insulation of non industrial buildings (First revision)</td>
</tr>
<tr>
<td>3837-1976</td>
<td>Accessories for rigid steel conduits for electrical wiring (First revision).</td>
</tr>
<tr>
<td>3844-1989</td>
<td>Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (First revision)</td>
</tr>
<tr>
<td>3847- 1992</td>
<td>Specification for mortice night latches (First revision).</td>
</tr>
<tr>
<td>3854-1966</td>
<td>Switches for domestic and similar purposes.</td>
</tr>
<tr>
<td>3908- 1986</td>
<td>Aluminium equal leg angles (First revision)</td>
</tr>
<tr>
<td>3909- 1986</td>
<td>Specifications for aluminium unequal leg angles (First revision)</td>
</tr>
<tr>
<td>3921- 1985</td>
<td>Aluminium channel (First revision)</td>
</tr>
<tr>
<td>3954- 1991</td>
<td>Hot rolled steel channel sections for engineering purposes-dimensions (First revision)</td>
</tr>
<tr>
<td>3989-1984</td>
<td>Specification for centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories (Second revision).</td>
</tr>
<tr>
<td>4000- 1992</td>
<td>Code of practice for high strength bolts in steel structures. (First revision)</td>
</tr>
<tr>
<td>4004-1985</td>
<td>Application guide for non-linear resister-type surge arrestors for Alternating Current systems (First revision).</td>
</tr>
<tr>
<td>4014- (Part 2)1967</td>
<td>Code of Practice for steel tubulars scaffolding; Part 2, Safety regulations for scaffolding.</td>
</tr>
<tr>
<td>4020- (part 1 to 16) 1998</td>
<td>Method of Tests: Door shutters (Third Revision)</td>
</tr>
<tr>
<td>4031- Part 7 - 1988</td>
<td>Method of tests for hydraulic cement Part 7 Compressive Strength Test of masonry cement (First Revision)</td>
</tr>
<tr>
<td>4038-1986</td>
<td>Specification for Foot Valves for water works purposes (Second revision)</td>
</tr>
<tr>
<td>4081- 1986</td>
<td>Safety code for blasting and related drilling operation (First revision).</td>
</tr>
<tr>
<td>4111-Part 1 -1986</td>
<td>Code of Practice for Ancillary Structures in Sewerage System: Manholes (First Revision)</td>
</tr>
<tr>
<td>4111-Part 2 - 1985</td>
<td>Code of Practice for Ancillary Structures in Sewerage System: Flushing tanks (First Revision)</td>
</tr>
<tr>
<td>4111- Part 3 - 1985</td>
<td>Code of Practice for Ancillary Structures in Sewerage System: Inverted Siphon (First Revision)</td>
</tr>
<tr>
<td>4111-Part 4 - 1968</td>
<td>Pumping Stations and Pumping Mains(Rising Mains)</td>
</tr>
<tr>
<td>4137-1985</td>
<td>Code of practice for heavy duty electric overhead travelling cranes</td>
</tr>
<tr>
<td>Specification Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>4160-2005</td>
<td>Specification for Interlocking switch socket outlet (First revision).</td>
</tr>
<tr>
<td>4346-1982</td>
<td>Specification for washer for use with fittings for water services (First revision).</td>
</tr>
<tr>
<td>4351-2003</td>
<td>Specification for steel doors frames (Second revision).</td>
</tr>
<tr>
<td>4578-1997</td>
<td>Specification for Lubricating oil for refrigeration machinery (Second revision).</td>
</tr>
<tr>
<td>4615-1968</td>
<td>Switch socket outlets (non-interlocking type).</td>
</tr>
<tr>
<td>4926-2003</td>
<td>Code of Practice for Ready Mixed Concrete (Second Revision).</td>
</tr>
<tr>
<td>4984-1995</td>
<td>Specification for high density polyethylene pipes for potable water supplies (Fourth revision).</td>
</tr>
<tr>
<td>5329-1983</td>
<td>Code of Practice for Sanitary Pipe work above ground for building (First Revision).</td>
</tr>
<tr>
<td>5382-1985</td>
<td>Specification for rubber seating rings for gas mains, water mains and sewers (First revision).</td>
</tr>
<tr>
<td>5410-1992</td>
<td>Specification for cement paint (First revision).</td>
</tr>
<tr>
<td>5411-(Part 1)-1974</td>
<td>Plastic emulsion paint, Part 1 for interior use. (First revision).</td>
</tr>
<tr>
<td>5411-(Part 2)-1972</td>
<td>Plastic emulsion paint Part 2, for exterior use.</td>
</tr>
<tr>
<td>5437-1994</td>
<td>Specification for wired and figured glass. (First revision).</td>
</tr>
<tr>
<td>5454-1978</td>
<td>Methods for Sampling of Clay Building Brick (First Revision).</td>
</tr>
<tr>
<td>5455-1969</td>
<td>Specification for cast iron steps for manholes.</td>
</tr>
<tr>
<td>5522-1992</td>
<td>Stainless steel sheets and strips for utensils (Second revision).</td>
</tr>
<tr>
<td>5523-1983</td>
<td>Method of testing for anodic coating on aluminium and its alloys (First revision).</td>
</tr>
<tr>
<td>5531-1988</td>
<td>Specification for cast iron specials for asbestos cement pressure pipes for water, gas and sewage (Second revision).</td>
</tr>
<tr>
<td>5578-1984</td>
<td>Guide for marking of insulated conductors (First revision).</td>
</tr>
<tr>
<td>5613-(Part 1 Sec.1)-1985</td>
<td>Code of Practice for design installation and maintenance of overhead power lines. Lines upto and including 11KV Section I: Design. (First revision).</td>
</tr>
<tr>
<td>5613-(part 1 See 2)-1985</td>
<td>Code of Practice for design installation and maintenance of overhead power lines. Section 2: Installation and maintenance. (First revision).</td>
</tr>
<tr>
<td>5691-1970</td>
<td>Lacquers, cellulose, pigmented finishing, glossy.</td>
</tr>
<tr>
<td>5714-1981</td>
<td>Specification for Hydrant Stand-Pipe for Fire Fighting (First revision).</td>
</tr>
<tr>
<td>Standard Number</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>6165-1992</td>
<td>Dimensions for Special Shapes of Clay Bricks (First Revision)</td>
</tr>
<tr>
<td>6241-1971</td>
<td>Method for Test for Determination of Stripping Value of Road Aggregate.</td>
</tr>
<tr>
<td>6248-1979</td>
<td>Specification for metal rolling shutters and rolling grills (First revision)</td>
</tr>
<tr>
<td>6272-1987</td>
<td>Industrial cooling fans (man coolers) (First revision)</td>
</tr>
<tr>
<td>6295-1986</td>
<td>Code of practice for water supply and drainage in high altitudes and/or sub-zero temperature regions (First revision)</td>
</tr>
<tr>
<td>6313-(Part-I) 1981</td>
<td>Anti-termite measure in building constructional measures (First revision).</td>
</tr>
<tr>
<td>6313-(Part-2) 1981</td>
<td>Anti-termite measure in building Part 2: Pre constructional chemical treatment measures (Second revision).</td>
</tr>
<tr>
<td>6313-(Part-3) 1981</td>
<td>Anti-termite measure in building Part 3: Treatment for Existing Building (Second revision).</td>
</tr>
<tr>
<td>6315-1992</td>
<td>Specification for floor springs (hydraulically regulated) for heavy doors (Second revision).</td>
</tr>
<tr>
<td>6445-1985</td>
<td>Aluminium tee sections (First revision)</td>
</tr>
<tr>
<td>6639-2005</td>
<td>Specification for hexagon head bolts for general steel structures. (First revision)</td>
</tr>
<tr>
<td>6925-1973</td>
<td>Method of Test for Determination of Water Soluble Chlorides in Concrete Admixtures.</td>
</tr>
<tr>
<td>7098-(Part 1)-1988</td>
<td>Crosslinked Polyethylene (XLPE) insulated PVC Sheathed Cables: Part 1 For working voltage upto and including 1100 Volts. (Second revision)</td>
</tr>
<tr>
<td>7098-(Part 2)-1985</td>
<td>Crosslinked Polyethylene (XLPE) insulated PVC Sheathed Cables. For working voltage from 3.3 KV upto and including 33 KV (First revision).</td>
</tr>
<tr>
<td>7164-1973</td>
<td>Specification for Stopper</td>
</tr>
<tr>
<td>7205-1974</td>
<td>Safety code for erection of structural steel work.</td>
</tr>
<tr>
<td>7215-1974</td>
<td>Tolerances for fabrication of steel structures.</td>
</tr>
<tr>
<td>7328-1992</td>
<td>Specification for high density polyethylene materials for moulding and extrusion (First revision).</td>
</tr>
<tr>
<td>7403-1974</td>
<td>Code of practice for selection of worm and helical gear boxes</td>
</tr>
<tr>
<td>7452-1990</td>
<td>Specification for hot rolled steel sections for doors, windows and ventilators. (Second revision)</td>
</tr>
<tr>
<td>7534-1985</td>
<td>Specification for sliding locking bolts for use with pad-locks (First revision).</td>
</tr>
<tr>
<td>7613-1975</td>
<td>Method of testing for panel type air filters for air conditioning purposes</td>
</tr>
<tr>
<td>7634-(Part 2) 1975</td>
<td>Code of practice for plastics pipe, work for potable water supplies: Laying and jointing polyethylene (PE) pipes</td>
</tr>
<tr>
<td>7634-(Part 3) 2003</td>
<td>Code of practice for plastics pipe, work for potable water supplies: Laying and jointing of PVC pipes (First revision)</td>
</tr>
<tr>
<td>7673-2004</td>
<td>Fire Fighting Equipment - Glossary of Terms</td>
</tr>
<tr>
<td>Code of Practice for Construction and Maintenance of Road Gullies (First Revision).</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Code of Practice for Extreme Weather Concreting - Part I: Recommended Practice for Hot Weather Concreting</td>
<td></td>
</tr>
<tr>
<td>Code of Practice for Extreme Weather Concreting - Part II: Recommended Practice for Cold Weather Concreting</td>
<td></td>
</tr>
<tr>
<td>Data for outside design conditions for AC in summer months (First revision)</td>
<td></td>
</tr>
<tr>
<td>Safety Code for storage and handling of building materials.</td>
<td></td>
</tr>
<tr>
<td>Specification for injection moulded high density polyethylene (HDPE) fittings for potable water supplies. Part 1: General requirements (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for injection moulded high density polyethylene (HDPE) fittings for potable water supplies. Part 2: Specific requirements for 900 bends. (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for injection moulded high density polyethylene (HDPE) fittings for potable water supplies. Part 3: Specific requirements for 900 TEE (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for injection moulded high density polyethylene (HDPE) fittings for potable water supplies. Part 4: Specific requirements for reducers (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for injection moulded high density polyethylene (HDPE) fittings for potable water supplies. Part 5: Specific requirements for ferrule reducers (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for injection moulded high density polyethylene (HDPE) fittings for potable water supplies. Part 6: Specific requirements for pipe ends (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for white Portland cement (Second revision)</td>
<td></td>
</tr>
<tr>
<td>43 Grade Ordinary Portland Cement -Specifications (First Revision)</td>
<td></td>
</tr>
<tr>
<td>Specification for fabricated high density polyethylene (HDPE) fittings for potable water services: General requirements, specific requirement for 900 TEE bends.</td>
<td></td>
</tr>
<tr>
<td>Copper and copper alloy rolled plates for condensers</td>
<td></td>
</tr>
<tr>
<td>Cranes -Design Principles for Loads and Load Combination</td>
<td></td>
</tr>
<tr>
<td>Cranes-Design Principles for Loads and Load Combinations: Part 5: Overhead Travelling and Portal Bridge Cranes</td>
<td></td>
</tr>
<tr>
<td>Glossary of terms Associated with Fire Safety</td>
<td></td>
</tr>
<tr>
<td>Specification for Chloropyrifos emulsifiable concentrate (First revision).</td>
<td></td>
</tr>
<tr>
<td>Concrete Admixtures- Specification (First revision).</td>
<td></td>
</tr>
<tr>
<td>Cranes and Related Equipment -Accuracy Requirements for Measuring Parameters During Testing</td>
<td></td>
</tr>
<tr>
<td>High voltage; Part 2 expulsion fuses and similar fuses; Part 3 Application guide</td>
<td></td>
</tr>
<tr>
<td>Sprayed mineral wool insulation (First revision)</td>
<td></td>
</tr>
<tr>
<td>Specification for polyethylene floats (spherical) for float valves (First revision).</td>
<td></td>
</tr>
<tr>
<td>Specification for Preformed fibrous insulation (First revision)</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Year</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>9900-(Part 1 to 4) 1981</td>
<td>High Pressure mercury vapour lamps - Part 1 to Part 4</td>
</tr>
<tr>
<td>10019- 1981</td>
<td>Specification for mild steel stays and fasteners</td>
</tr>
<tr>
<td>10470-1983</td>
<td>Specification for Air cooled Heat Exchangers</td>
</tr>
<tr>
<td>10500-1991</td>
<td>Specification for drinking water (First revision)</td>
</tr>
<tr>
<td>10594-1983</td>
<td>Thermostatic Expansion valves</td>
</tr>
<tr>
<td>10609-1983</td>
<td>Refrigerants - numbers - designation</td>
</tr>
<tr>
<td>10617-1983 Pt 1.2 &amp;3</td>
<td>Specification for Hermetic Compressors</td>
</tr>
<tr>
<td>11101-1984</td>
<td>Specification for Extended Branch Pipe for Fire Brigade Use</td>
</tr>
<tr>
<td>11208-1985</td>
<td>Guide lines for registration of plumbers</td>
</tr>
<tr>
<td>11327-1985</td>
<td>Requirements for Refrigerant Condensing unit</td>
</tr>
<tr>
<td>11329-1985</td>
<td>Finned type heat exchangers for room air conditioners</td>
</tr>
<tr>
<td>11330-1985</td>
<td>Specification for Oil separators</td>
</tr>
<tr>
<td>11338-1985</td>
<td>Specification for Thermostats for use in refrigeration and air conditioning</td>
</tr>
<tr>
<td>11883-1986</td>
<td>Ready mix Paint, brushing red oxide, priming for metals.</td>
</tr>
<tr>
<td>12027-1987</td>
<td>Specification for silicone based water repellents</td>
</tr>
<tr>
<td>12269 - 1989</td>
<td>Specification for 53 Grade Ordinary Portland Cement</td>
</tr>
<tr>
<td>12349-1988</td>
<td>Fire protection-safety signs</td>
</tr>
<tr>
<td>12407-1988</td>
<td>Graphic symbols for fire protection plans</td>
</tr>
<tr>
<td>12436-1988</td>
<td>Preformed rigid polyurethane foams for thermal insulation</td>
</tr>
<tr>
<td>12615-2004</td>
<td>Specification for Induction motors - Energy Efficient motors</td>
</tr>
<tr>
<td>12701-1996</td>
<td>Specification for &quot;Rotational Moulded polyethylene water storage tanks. (First revision)</td>
</tr>
<tr>
<td>12753-1989</td>
<td>Eletrogalvanized coatings on round steel wire-specifications.</td>
</tr>
<tr>
<td>12778-2004</td>
<td>Hot rolled parallel, flange steel sections for beams, columns and bearing piles dimensions and section properties. (First revision)</td>
</tr>
<tr>
<td>12817-1997</td>
<td>Specification for stainless steel butt hinges (First revision).</td>
</tr>
<tr>
<td>12843-1989</td>
<td>Tolerances for erection of steel structure</td>
</tr>
<tr>
<td>12866-1989</td>
<td>Specification for plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced)</td>
</tr>
<tr>
<td>Reference</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>13592-1992</td>
<td>Specification for UPVC pipes for soil and waste discharge systems inside buildings including ventilation and rainwater system</td>
</tr>
<tr>
<td>13712-2006</td>
<td>Ceramic tiles- definitions, classifications, characteristics and marking (First revision),</td>
</tr>
<tr>
<td>13753-1993</td>
<td>Specification for dust pressed Ceramic tiles with water absorption of E&gt;10%Group (B III)</td>
</tr>
<tr>
<td>13755-1993</td>
<td>Specification for dust pressed Ceramic tiles with water absorption of 3%&lt;E&lt;6%Group (BII a)</td>
</tr>
<tr>
<td>13757-1993</td>
<td>Specification for burnt clay fly ash building bricks</td>
</tr>
<tr>
<td>13834-1994</td>
<td>Cranes -Classification Part 1 General</td>
</tr>
<tr>
<td>13834-Part 5 - 1993</td>
<td>Cranes -Classification: Part 5 Overhead traveling and portal bridge cranes</td>
</tr>
<tr>
<td>13870-1993</td>
<td>Cranes and lifting appliances -Selection of wire ropes: Part 1 General</td>
</tr>
<tr>
<td>13871-1993</td>
<td>Specification for powder coatingss</td>
</tr>
<tr>
<td>13947-Part 1 to 4 - 1993</td>
<td>Specification for low voltage switchgear and control gear</td>
</tr>
<tr>
<td>14164-1994</td>
<td>Industrial application and finishing of thermal insulation material at temperature above 80 deg C and upto 700 deg Co Code of Practice</td>
</tr>
<tr>
<td>14333-1996</td>
<td>Specification for high density polyethylene pipe for sewerage</td>
</tr>
<tr>
<td>14471-1997</td>
<td>Cranes and lifting appliances - Technical characteristics and acceptance documents</td>
</tr>
<tr>
<td>14472-Part 5 - 1997</td>
<td>Cranes-Information to be provided: Part 5 Overhead travelling cranes and portal bridge cranes</td>
</tr>
<tr>
<td>14473-Part 1 - 1997</td>
<td>Cranes - Inspections: Part 1 General</td>
</tr>
<tr>
<td>14665-(Part-1) - 2000</td>
<td>Electric Traction Lifts (Part-1 Guidelines for dimensions of passenger, goods, service and hospital lifts)</td>
</tr>
<tr>
<td>14665-(Part-2)Sec 1&amp;2</td>
<td>Electric Traction Lifts (Part-2 Codeof practice for installation,2000: operation and maintenance. Sec 1- Passenger and Goods Lifts, Sec 2-Service Lift)</td>
</tr>
<tr>
<td>14665-(Part-3)Sec 1 &amp;2</td>
<td>Electric Traction Lifts (Part-3 Safety Rules, Sec 1- Passenger and 2000Goods Lifts, Sec 2-Service Lifts)</td>
</tr>
<tr>
<td>14665-(Part-4)</td>
<td>Electric Traction Lift(Part 4 components) Sec 1to9)- 2001</td>
</tr>
<tr>
<td>Code Reference</td>
<td>Description</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>14687-1999</td>
<td>Guidelines on falsework for concrete structures</td>
</tr>
<tr>
<td>14735-1999</td>
<td>Specification for unplasticized polyvinyl chloride (UPVC) injection moulded fittings for soil and waste discharge system for inside and outside buildings including ventilation and rain water system.</td>
</tr>
<tr>
<td>14772-2000</td>
<td>General requirements for enclosures for accessories for house hold and similar fixed electrical insulations.</td>
</tr>
<tr>
<td>14846-2000</td>
<td>Service valve for water works purposes (50 to 1200 mm size) specification.</td>
</tr>
<tr>
<td>14912-2001</td>
<td>Specification for door closers, concealed type (hydraulically regulated)</td>
</tr>
<tr>
<td>14961-2001</td>
<td>High Pressure Fire Fighting Hose -Specification</td>
</tr>
<tr>
<td>15051-2001</td>
<td>High Pressure Fire Hose Delivery Couplings -Specification</td>
</tr>
<tr>
<td>15105-2002</td>
<td>Code of Practice for Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems</td>
</tr>
<tr>
<td>15301-003</td>
<td>Code of Practice for Installation and Maintenance of Fire Fighting Pumps</td>
</tr>
</tbody>
</table>

**IRC STANDARDS**

<table>
<thead>
<tr>
<th>Code Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-1961</td>
<td>Recommended practice for borrow pits for road, embankments constructed by manual operation.</td>
</tr>
<tr>
<td>36-1970</td>
<td>Recommended practice for construction of earth embankments for road works.</td>
</tr>
</tbody>
</table>
Indian Standard

The following IS with latest revision apply to this Section:

<table>
<thead>
<tr>
<th>I.S.NO</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>3764-1966</td>
<td>Safety code for excavation work including Amendment No-1 of March 1976</td>
</tr>
<tr>
<td>4081-1986</td>
<td>Safety code for blasting and related drilling operations (first revision)</td>
</tr>
<tr>
<td>631 3(part-II)-1981</td>
<td>Anti-Termite Measures in Building Pre-Constructional Chemical treatment measures( first revision)</td>
</tr>
</tbody>
</table>

3.1 Classification

3.1.1 The materials to be excavated shall be classified as under

(a) **Soft or loose Soil** :- Generally any soil which yields to the ordinary application of pick and shovel or to phowara, rake or other ordinary digging implements such as vegetable or organic soil, turf gravel, soil classified under soil group SP, SC, ML, CL, OL, MI, CI, OI, MM, CH and OH having soil dry density less than 1.80 gm/ cc as per IS 1498-1970. This will also include mud phuska, etc.

(b) **Hard or Dense Soil** :- Soil group as per IS-1498-1970 other than covered under (a) above; gravel, cobble stone, hard shale, soft conglomerate where stone can be detached from the matrix with picks and shovels. This will also include hard core, soling of roads, path etc; macadam surface of any description (water bound, grouted, tarmac); lime concrete stone masonry in lime mortar and brick work in lime or cement mortar below ground level.

**Note**: Cobble stone is rounded to angular, bulky, hard rock particle, average diameter smaller than 300 mm but retained on 80mm IS sieve.

(c) **Mud** :- A mixture of soil and water in fluid or weak solid state.

(d) **Soft or Disintegrated Rock (Not requiring blasting)** :- Rock or boulders which may be quarried or spilt with crowbars. This will also include laterite and hard conglomerate; plain cement concrete which can be broken up with crowbars or picks and stone masonry in cement mortar below ground level.

(e) **Hard Rock** :- Any rock (excluding laterite and hard conglomerate) or boulder for excavation for which blasting is required. This will also include plain cement concrete for the excavation for which blasting is required; reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level.

(f) **Hard Rock (Blasting Prohibited)** :- Hard rock requiring blasting as described under (e) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling or any other agreed method.

3.2.2 A broad classification of soil and rock for earthwork, suitable for conditions generally occurring in practice, has been given. The classification of the soil shall be made by the consultant and Engineer In Charge during the process of excavation and the contractor shall give due notice for inspection at every stage of excavation and to record the classification of soil according to the strata present...
3.1.2 Authority of Classification:

The Classification of soils shall be decided by the consultant and Engineer – in – Charge and this decision shall be final and binding on the contractor. Merely the use of Explosives in excavation shall not be considered as a reason to classify hard rock, unless blasting is clearly authorized by the Engineer – in – Charge.

3.2 Types of Excavation

3.2.1 Rough Excavation:

Excavation not requiring dressing of sides and bottom and reduction to exact levels such as winning earth from borrow pits; hillside cutting etc., shall be described as 'rough excavation'.

3.2.2 Surface Excavation:

Excavation exceeding 1.5 m in width as well as 10 sq. m area on plan; but not exceeding 30 cm in depth shall be described as 'surface excavation'.

3.2.3 Excavation over Areas:

Excavation exceeding 1.5 m in width as well as 10 sq. m area on plan and exceeding 30 cm in depth shall be described as 'excavation over areas.'

3.2.4 Excavation in Trenches for Foundations for pipes, Cables etc.:

Excavation in trenches for foundations and for pipes, Cables, etc. (not exceeding 1.5 m in width) and excavation for manholes, Shafts, Cesspits, Wells and the like not exceeding 10 sq. m on plan, shall be described as 'excavation in trenches'.

3.2.5 Excavation in Post Holes:

Excavation in independent post holes (or similar holes) each not exceeding 0.5 cu. m shall be described as 'excavation in post holes' and shall include return, filling and removal of surplus spoil.

3.2.6 Surface Dressing:

Trimming of natural ground, rough excavated surface and filled up area to remove vegetation and or small inequalities not exceeding 15 cm deep shall be described as surface dressing'.

3.3 Antiquities and Useful Materials:

Any finds such as relics or antiquity, coins, fossils or other articles of value shall be delivered to the EIC and shall be the property of the HAL.

3.3.1 Any Useful Material obtained from the excavation shall be stacked separately in the regular stacks as directed by the EIC and shall remain the property of the HAL. The decision of the EIC as to what is useful and what is useless shall be final and binding.

3.3.2 Any useful material, directed to be used by the contractor in lieu of his own supply will be charged to the contractor at the agreed rates or paid excluding the cost of such materials.

3.4 Inspection of site:

The contractor shall be responsible to inspect the site of work and ascertain the nature of the ground in which the excavation is to be carried out.

3.5 Site Clearance:

Before the work is started, the area coming under cutting and filling shall be cleared of shrubs vegetation, grass, bush weed, trees and saplings not exceeding 30 cm in girth, measured at a height of 1 m above the ground level. Useful materials shall be stacked and rubbish / useless materials disposed off at the place directed by the Engineer – in –Charge. Roots of trees and saplings shall be removed as described under felling of trees and the hollows filled up with earth, levelled and rammed.
3.6 Felling of Trees:

Trees exceeding 30 cm in girth when measured at the height of 1 m above ground level and which are to be cut shall be so approved in writing by the EIC and marked at site. Felling of trees shall include digging out roots up to 60 cm below the ground level or 50 cm below the formation level, whichever is lower. All holes and hollows, formed in the ground by, digging of roots shall be carefully filled with earth, well rammed and leveled. Boulders which may interfere with the work shall be removed, after breaking down,’ if necessary.

3.6.1 The trunk and branches of the trees shall be cut into suitable pieces as directed. Useful materials shall be initially stacked at site of work as directed by EIC and will be property of the HAL. All serviceable material and rubbish shall be removed to a distance up to 1.5Km outside the periphery’ of the area under clearance and burnt or otherwise disposed off as directed.

3.7 Setting out and making profiles:

3.7.1 All excavation, embankments, traverses etc., shall be set out to the true line, curve, level or slope required. The contractor shall be responsible for the accuracy of all setting out.

3.7.2 Masonry pillars shall be erected at suitable points in the area to serve as benchmarks for the execution of the work. These benchmarks shall be connected with any permanent benchmark. In case of filling necessary profiles with pegs, bamboos, and string or ‘burjis’ shall be made to show the correct formation level before the work is started. In case of cutting, levels may be marked by the designing pits and embedding bricks bats at the required levels. The profiles and ‘burjis’ shall be maintained during the execution of the work.

3.7.3 The ground levels shall be taken on roughly level ground ordinarily at 15m distance. In sloping and undulation areas, levels shall be taken at lesser distance depending on ground conditions. The ground level shall be recorded in the field level books and plotted on plans, and signed jointly by EIC and the contractor before the earthwork is started. The labour required for taking levels shall be supplied by the contractor at no extra cost to HAL.

3.8 Surface Dressing

Uneven surfaces of the natural ground, rough excavated surfaces and filled up area where ordered shall be trimmed to an uneven surface, horizontal or sloping, by removing vegetation and by scraping high patches and filling in low patches with the scraped soil to give an even and neat look to the site. The maximum depth of cutting shall not exceed 15 cm.

3.9 Rough Excavation

The locations and depths of borrow pits and the extent of hillside cutting shall be indicated by the EIC. Sufficient number of telltales or dead man shall be left in position as indicated by the EIC for proper measurements of excavation. Such tell tales shall not be removed until after the measurements of rough excavation have been recorded in the measurement book. Where practicable, borrow pits shall be drained to prevent stagnation of water in them.

3.10 Excavation Generally

3.10.1 All excavation (except rough excavation) shall be paid to the exact dimensions and profiles as shown on the drawing and the Quoted rate shall include cost for working space / allowances as per applicable standards or as directed by the EIC. However authorized width as per SSR or IS 1200 will be paid.

3.10.2 Disused foundations drains or other obstructions met with during excavation shall be grubbed up and cleared away to the extent required.

3.10.3 Damage to the existing Drains, Water mains, cables, etc:

During excavation the contractor shall take particular care to avoid damage to the existing drains, water mains, cables or other underground work. Where required, existing pipes, cables etc. shall be properly slung or otherwise supported and report to the Engineer – in – Charge for receiving instruction regarding further course of action.
3.10.4 Top spit and other vegetable matter shall be separated from excavated material if so directed.

3.10.5 Bad Ground:

If during excavation the contractor encounters, expansive soil or other bad ground, he shall immediately notify it to EIC for his instructions in writing.

3.10.6 Inspection and Approval:

The contractor shall notify the EIC when excavation is ready for inspection. The excavation shall be inspected and passed by the EIC in writing, measurements recorded in the measurement book before foundation is laid.

3.11 Excavation in Trenches and Over Areas in Soil

3.11.1 In firm soil the sides of excavation shall be kept vertical up to a depth of 1.5 m from the bottom. For greater depth excavation profile may be widened or the sides sloped or shored up, depending upon the nature of soil. As ordered by the EIC in writing. It shall be responsibility of the contractor to take complete instructions from the EIC, in regarding the extent and manner of stepping, sloping or shoring and timbering to be done for excavations, where necessary.

3.11.2 Excavation shall be done from top to the bottom. Undermining and underpinning shall not be allowed.

3.11.3 The bed of excavation shall be formed to the required level, slope or grade shall be made firm by watering and ramming. The side of excavation shall be dressed or trimmed. Soft defective spots shall be dug out and filled with concrete of the same mix as that of the base concrete or approved dry filling as directed by the EIC.

3.11.4 If the excavation is done to a depth greater than that shown in the drawings or directed; the excess depth shall be made good by the contractor at his own expense with the concrete of the same proportion as base concrete. However, for excavation in drain work the excess depth shall be made good with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched.

3.11.5 In trench excavation for pipes etc., grips shall be dug, if required, to take sockets, collars and joints of pipes.

3.12 Blasting of Rocks

3.12.1 The contractor shall obtain license from the district authorities, where applicable, for undertaking blasting work and for obtaining and storing the explosives as per the Explosives rules, 1940, corrected up to date. The contractor shall purchase explosives, fuses, detonators only from the licensed dealers. He will be responsible for their safe custody and shall maintain an appropriate account of the explosive materials. The EIC or his authorized representatives shall have access to check the contractor's stock of explosives.

Fees, License or any other statutory provisions shall be strictly complied with and all the expenses towards the same shall be borne by the contractor.

3.12.2 Precautions:

Blasting operations shall be carried out under careful supervision of a responsible authorized person preferably during certain specified hours. Only trained person shall be employed. The blasting time shall be notified in advanced to the surrounding areas.

All precautions shall be taken to avoid accidents and to ensure safety of workers, public and property during blasting operations. Red flags shall be prominently displayed around the area to be blasted and all the people on work except those who actually light the fuses, shall withdraw to a safe distance of not less than 200 m from the blast.

All the procedures and safety precautions for the use of explosives, drilling and loading of the explosives’
e before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081-1986, safety code for blasting and related drilling operations. The EIC shall be informed by the contractor of all cases of misfires their causes and the steps taken in that direction.

The Insurance with respect to blasting requires to man and materials shall be obtained. This shall be either specifically covered in the Contractors all risk policy as stipulated in the General Condition of Contract or separate insurance policy shall be obtained for specific purpose.

3.13  Balling / Pumping of water

All water that may accumulate in excavations during the progress of work from subsoil water, springs or any other cause shall be bailed / pumped out or otherwise removed. The foundations 'shall be kept dry during excavation and laying of foundations. Pumping shall be done directly from the foundation trenches or from a sump outside the excavation as necessary in such a manner, as to preclude the possibility of movement of water through any fresh concrete or masonry and washing, away the parts of 'concrete or mortar. No pumping shall be allowed during laying of concrete or masonry and for a period of at least 24 hours thereafter unless it is done from a suitable sump separated from concrete or masonry by effective means. Pumping shall be done in such a way as not to damage to the work or adjoining property by blows, subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby. Dewatering / Bailing out of water in all locations of work site and from the excavated trenches, pits / area shall be bailed out / pumped out as necessary by the contractor at his own cost. The contractor shall arrange sufficient mechanism to pump out the water depending upon the accumulation of water in the trenches etc.

3.14  Protection

The contractor shall protect the excavation from the effect of frost other damage and shall make good such damage to the satisfaction of the EIC. Fencing and other precautions such as red flags and red lights at night etc. as necessary for protection against risk of accidents due to open excavation shall be provided. While carrying out excavation near a building, care shall be taken to see that proper shoring etc required is 'provided so as not to adversely affect, the foundation of adjacent building.

3.15.1 Filling Excavated Earth in Foundation Trench, in plinth and Under Floor etc.

The earth used for filling shall be free from salts, organic and other deleterious matter. Highly expensive soils like black cotton soil shall not be used, unless so specified. All clods of earth exceeding 50 mm shall be broken or removed. Earth obtained from borrow pits and surplus earth from excavation, if any, shall be directly used for filling and double handling avoided to the extent practicable.

3.15.2 Filling sides of trenches:

As soon as the work in foundation has been completed and measured, the space around foundation masonry in trenches shall be cleared of all debris, brickbats, etc. and filled with earth in layers not exceeding, 250 mm, each layer being watered, rammed and compacted before the succeeding one is laid. Earth shall be rammed with iron rammer where feasible and with the butt ends of crowbar where rammer cannot be used.

3.15.3 Filling Plinth, Under Floor and hardstanding etc.

Filling shall be started from the lowest level in regular horizontal layers each not exceeding 250 mm in depth. Each layer shall be compacted by ramming with rammers of 7 to 10 kg weight. Earth filling shall be adequately watered for achieving maximum compaction. Special care shall be taken to compact the filling at the junctions of the floors with walls and columns. The top surface of the filling shall be neatly dressed level or to slope or grade as directed. In large floors, like factory floors/ hangers, hard standing etc., each layer of earth filling shall be compacted by the mechanical means such as by sheep foot-roller or by hand roller or by power roller, compactors/rammers to 90 to 95 percent of standard Proctor's density under optimum moisture conditions.

3.16  Filling in Trenches for pipes, drains, cables, etc.

3.16.1 Material for filling:

Earth used for filling shall be free -from salts, organic or other deleterious matter. All clods of earth exceeding 50 mm shall be broken or removed. Unless otherwise indicated, where the excavated material is mostly rock, the rock fragment shall be broken into pieces not bigger than 150 mm size and mixed with fine
material consisting of decomposed rock moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling.

3.16.2 Filling Trenches:

Filling in trenches for pipes and drains shall be commenced only after the joints of pipes and drains have been tested and passed by the EIC in writing.

3.16.3 Where the trenches are excavated in soil the filling shall be done with earth on both the sides simultaneously and on top of pipes in layers not exceeding 250 mm thick, watered, rammed and compacted; taking care that no damage is caused to the pipe below.

3.16.4 In case of excavation in rock, the filling up to a depth of 300 mm above the crown of pipe shall be done with fine material such as earth, moorum or pulverized decomposed rock according to the availability at site, in the same manner as described for trenches excavated in soil. The remaining filling shall be done with rock fragments mixed with fine material as available to fill up the voids, watered, rammed and compacted, in layers not exceeding 250 mm thick. Particular care shall be taken in a back-filling to avoid future troubles from bursts and leakages due to differential settlement.


3.17.1 Moorum or Red bajri

Moorum or Red Bajri shall contain silicious material, and natural mixture of clay of calcareous origin. These shall not contain any admixture of ordinary earth. Bajri shall be dark red in colour consisting of coarse grains, free from mica, and other foreign matter. Size of moorum/red bajri shall vary from dust to 40 mm gauge.

3.17.2 Sand:

Sand shall be clean, free from dust, organic and other extraneous matter. It shall not contain more than 5 percent clay / silt.

3.17.3 Shingle:

Shingle shall be clean and free from foreign matters and obtained from river or nullah beds. Shingle of all in size ranging from 40 mm down to 4.75 mm gauge shall contain a sufficient proportion of fine material to fill all interstices and ensure binding when consolidated.

3.17.4 Filling:

Filling shall be done in a manner similar to earth filling in plinth except that thickness of individual layer shall not exceed 15cm. Shingle or ballast filling shall be blinded with earth before ramming / consolidation. The surface of the compacted moorum, red bajri. Sand or shingle shall be dressed to the required level, grade or slope. In the case of moorum and sand filling, surface shall be flooded with water for at least 24 hours, surface allowed to dry and compacted and graded. When the filling in floors etc. has nearly dried, any developing cracks shall be tapped and a thin layer of the same material as used for filling and earth in case of shingle filling shall be spread over the surface evenly and tapped. in.

3.18 Embankments and Traverses

3.18.1 Clearing the Site

Prior to commencement of earth work, the site shall be cleared of all obstruction and vegetation including trees, undergrowth grass, rubbish etc. All stumps shall be cut down below ground level as specified under ‘felling of trees’.

3.18.2 Embankments for road work etc shall be set out true to alignment, gradient, camber super elevation etc as indicated or directed by the EIC.

3.18.3 Compacting Original Grounds:

Original ground shall be compacted as much as possible by rolling or by other means like tamping where
0olling is not feasible. All empty pockets or depressions left in the soil as a result of clearing and grubbing operation shall be filled and compacted. Any unsuitable materials occurring in the embankment foundation shall be removed and replaced with approved materials.

3.18.4 Where an embankment is to be placed on steep sloping ground, the surface of the ground shall be benched in step or broken up in a manner that the new materials would bond with the existing surface.

3.18.5 Embankment work shall not proceed unless the foundations have been inspected by the EIC for satisfactory conditions and approved.

3.18.6 Earth for Filling:
Only approved earth shall be used in the embankment. All clods of earth exceeding 50 mm shall be broken or removed. Soils having maximum dry density of less than 1.44 gm/cc are ordinarily unsuitable and shall not be used unless specifically approved in writing by the EIC. Similarly soils having maximum dry density of 1.52 gm/cc are ordinarily considered not suitable for use in embankments exceeding 3 m in height or in embankments of any height subject to long periods of inundation. The work shall be so executed that the best available earth, is saved for the top portion of the embankment. Where highly expansive soils exhibiting marked swell and shrinkage properties indicated to be used in filling, these shall be deposited at the bottom of the embankment and no such materials shall be placed in the top 50 cm portion of the embankment below the sub grade.

3.18.7 Placing Soil:
Earth shall be deposited in layers not exceeding 25 cm. When a sheep foot roller is used, the thickness of the layer shall not exceed the length of the stamping foot by more than 5 cm. For adequate compaction the embankment shall be constructed in uniform layers spread over the entire width of embankment. Successive layers shall not be placed unless the layers under construction have been thoroughly compacted to satisfy the specified requirements.

3.18.8 Compaction:
Each layer shall be thoroughly compacted with sheep foot and/or power road roller of weight not less than 8 tones till the soil behaves as an elastic material and gets compressed under the load of the roller. In location where consolidation by power roller is not possible, manually or mechanically operated rammers shall be employed for Compaction. The embankment shall be finished to the lines, grades and cross section as directed. The compaction of earth filling in embankments shall be carried out under optimum conditions, so as to obtain at least, 95 percent of standard Proctor density for each layer. Dry density shall be determined in accordance with IS-2720 (Pt VII). Method of tests for soils (Part VII)- Determination of water content-dry density relation for soils (Part VII)- Determination of water content-dry density relation using light compaction. The moisture content of each layer of soil at the time of compaction should be from 1% above to 2% below the optimum moisture content. Highly expansive clays (such as black cotton soil) where specified to be used, should be compacted at a moisture content of 3-4 percent above the optimum to a density not exceeding 90% of standard Proctor's density.

3.18.9 Allowance for Settlement:
To allow for subsequent settlement of embankment, the finished level of the embankment shall be set higher than the specified level by 1-2 percent of the height of the embankment.

3.18.10 Compaction Control:
Proper record of compaction tests carried out shall be maintained. Density measurements shall be done at the rate of 1 test per 500-1000 Sqm of the compacted area, except where otherwise indicated.

3.19 Subsidence And Shrinkage
The contractor shall make good all subsidence and shrinkage in all earth fillings, embankments, traverses etc. during execution of work and thereafter until the expiry of defect liability period.

3.20 Timbering / planking and Strutting
3.20.1 When the depth of a trench in a soft but firm soil exceeds 1.5 m, stepping sloping and or planking and strutting of sides shall be done as ordered, in writing by the EIC. In the case of loose and slushy soil
3.20.2 It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of the trenches from collapse. Regarding the necessity or otherwise of timbering or any other safety measures, the contractor shall be responsible to obtain the decision of the EIC, in writing, failing which the contractor shall be liable for any damage caused due to non-adopting of proper timbering or other safety measures.

3.20.3 Deep excavation shall be inspected by the Contractor after every rain; storm or other hazard increasing occurrence and protection against slides and caving shall be increased, if necessary and as directed by the EIC.

3.20.4 Planking and strutting shall be ‘close’ or ‘open’ type depending on the nature of soil and the depth of trench. The type of planking and strutting shall be as indicated by the EIC. Where distinctly different types of soil strata are encountered, each strata shall be treated separately as required by its characteristics.

3.20.5 Timbering shall be of sufficient strength to resist earth pressure and ensure safety from slips, damage to the property or injury to person. Where excavation has also to stand vibrations from adjacent machinery, vehicles, railroads, blasting and other sources, additional bracings shall be provided. Generally the specification and sizes and spacing of sheeting, wales and struts used for timbering for different depths of trench shall be as given in IS 3764-1966 Safety code for excavation work. Shoring shall extend 30 cm above the vertical sides.

3.20.6 The withdrawal of timbering shall be done very carefully to prevent collapse of the sides of excavation and any damage to the work, executed in the excavated area. No Claim shall be entertained for any timber, which cannot be withdrawn and is lost or buried unless ordered by the EIC writing to be left permanently in position.

3.21 Preconstruction Anti-termite Chemical Treatment:

3.21.1 Chemical:

Anti termite treatment shall conforming to the IS 6313 specification in water emulsion shall be applied uniformly at the prescribed rate in all stages of treatment.

3.21.1.2 Concentration of the chemical as emulsifiable concentrate will be as indicated on the sealed containers. For obtaining the specified concentration, chemical shall be diluted with water in the required quantity before it is used. Graduated containers shall be used for the dilution of the chemical. For example, to dilute chemical of 30 percent concentration, 59 parts of water to one part of the chemical shall be added to achieve 0.5 percent concentration.

3.21.2 Mound Treatment:

If termite mounds are found within the plinth area of the building these shall be destroyed by pouring chemicals into the mounds at several places, after breaking open the earthen structure, and making holes with crow-bars, at the rate of 4 liters of chemical emulsion per cubic metre of mound.

3.21.3 Conditions of formation:

Barrier shall be complete and continuous under the whole of the building / structure to be protected. All foundations shall be fully surrounded by and in close contact with the barrier of treated soil. On loose, sandy or porous soils where loss of treating solution through piping or excessive percolation is likely to occur, preliminary moistening to fill the capillary spaces in soil may be done.

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

3.21.5 Disturbance:

Once formed, treated soil barriers shall not be disturbed. If treated soil barriers are distributed, immediate
3.21.6 **Treatment of Masonry Foundations and Basement:**

The bottom surface and the sides (up to a height of about 300 mm) of excavations made for masonry foundations and basements shall be treated with the chemical at the rate of 5 litres per square metre surface area. After the masonry foundations and the retaining wall of the basements come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 7.5 litres per square meter of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centers close to the wall surface and working the rod backward and soil should be tamped, in place. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the masonry surfaces so that the earth in contact with these surfaces is well treated with these chemicals.

3.21.6.1. **Treatment for RCC Foundations and Basements:**

The treatment shall start at a depth of 500 mm below the ground level except when such ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of 500 mm shall be determined from the new soil level resulting from the filling or cutting mentioned above, and soil in immediate contact with the vertical surfaces of RCC foundations shall be treated at the rate of 7.5 liters per square meter.

3.21.7 **Treatment of Top Surface of plinth filling:**

The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 liters per square meter of the surface before the sand bed / hardcore or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centers both ways may be made with 12 mm dia mild steel rods on the surface to facilitate saturation of the soil with the chemical emulsion.

3.21.8 **Treatment at Junctions of the wall and the floor:**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level upto the level of the filled earth surface. To achieve this, a small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the sub-base) and the rod holes made in the channel up to the ground level 150 mm apart and the iron rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 liters per square meter of the vertical wall or column surface so as to soak the soil right to bottom. The soil should be tamped back into place after this operation.

3.21.9 **Treatment of soil along External Perimeter of Building:**

After the building is complete but before laying plinth protection, holes shall be made in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and depth 300 mm and these holes shall be filled with chemical emulsion at the rate of 7.5 liters per sq. meter of vertical surface of perimeter of the external wall.

3.21.9.1 **Treatment of soil under apron along external perimeter of building:**

Top surface of the consolidated earth over the apron is to be laid shall be treated with chemical emulsion at the rate of 5 liters / Sqm of the vertical surface before the apron is laid. If consolidated earth does not allow emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centre both ways may be made with 12 mm diameter mild steel rod on the surface to facilitate saturation of soil with chemical emulsion.

3.21.10 **Treatment of soil surrounding pipes and conduits:**

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

The chemicals used for treatment are poisonous and hazardous to health. Therefore necessary safety precautions shall be taken by the Contractor in handling and use of the chemicals and emulsions.

3.22 Hard Core

3.22.1 Hard core shall be of hard broken stones or boulders, quarry waste, gravel, bricks of old broken concrete, as indicated. Material for hard core shall be hard, tough, clean and free from dust and other deleterious matter. The material for hard core shall be well graded for providing a dense and compact sub-grade. Where the gravel or concrete rubble, etc, are not well graded, it shall contain sufficient fine material for its proper compaction.

3.22.2 Unless otherwise indicated, materials for hard core shall be broken to gauge not exceeding 63mm. Hard core of gauge up to 100mm may be specified and used when laid in hard standing and pavements where power roller is used for consolidation.

3.22.3 Brick aggregate shall be from well burnt or slightly over burnt bricks and shall not contain any appreciable solution of sulphate content when used on a wet side.

3.22.4 Coarse ungraded gravel and rock may be used as a base layer for hard core exceeding 15cm thick covered by a layer of well graded material.

3.22.5 Concrete rubble shall be clean and suitably graded. Care shall be taken with rubble from general building demolition which may contain mixtures of material.

3.22.6 Hard core filling shall be spread and levelled in layers not exceeding 15cm thick, watered and well rammed or rolled where indicated.

Disposal of Surplus Excavated Material:

All Materials considered surplus shall be moved to destinations within the specified and disposed off as directed.

Measurements:

The measurement of Earthwork shall be done as specified in MES SSR 2004 – Part II and IS 1200.

Excavation shall be measured in CUM for each class of material encountered, limited to the dimension shown in the drawing including authorized widths or as directed by the consultant and Engineer – in – Charge. Excavation over increased width, cutting of slopes, shoring, shrutting and planking shall be deemed as convenience to the contractor in executing work and shall not be measured and paid for separately.

Rate:

Unless otherwise specified, the rate shall include the following:

Surveying, Setting Out,
Levelling the bottom to the required level/ Gradient, slope as directed by the consultant at all lifts and leads as specified in the BOQ for respective Items.
All Labour, material, tools, plants, equipments, Instruments in completing the excavation.
Following all the required and standard safety precautions.
Cost to Comply all statutory provisions as applicable.
Trimming the sides and bottom
Dewatering and keeping the work free from water
Disposal including loading, unloading, spreading initial staking etc., to the specified destinations and leads.
Excavation manually or by use of machinery. However machinery will not be permitted where service lines are passing through or it may cause damage/affect the adjoining structure.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
CONCRETE

Indian Standards

The following IS with latest revision apply to this section:

<table>
<thead>
<tr>
<th>I.S. No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>10262 -1982</td>
<td>Recommended Guide Lines for Concrete Mix Design</td>
</tr>
<tr>
<td>383-1970</td>
<td>Specification for coarse and fine aggregates from natural sources for concrete (Second revision)</td>
</tr>
<tr>
<td>516-1959</td>
<td>Method of test for strength of concrete.</td>
</tr>
<tr>
<td>1199-1959</td>
<td>Method of sampling and analysis of concrete.</td>
</tr>
<tr>
<td>2185 (part-I)-1979</td>
<td>Specification for load bearing, hollow concrete blocks (second revision)</td>
</tr>
<tr>
<td>2185 (Part-II)-1983</td>
<td>Specification for concrete masonry units Hollow and solid light weight concrete blocks (first revision)</td>
</tr>
<tr>
<td>2185 (Part-III)-1984</td>
<td>Specification for concrete masonry units Auto cleaved cellular (aerated) concrete blocks (first revision)</td>
</tr>
<tr>
<td>2645-1975</td>
<td>Specification for integral cement water proofing compounds (first revision)</td>
</tr>
<tr>
<td>4926 - 2003</td>
<td>Ready Mixed Concrete – Code of practice</td>
</tr>
<tr>
<td>7861 (part-I)-1971</td>
<td>Code of practice for extreme weather concreting Part 1-Recommended Practice for hot weather concreting</td>
</tr>
<tr>
<td>8112-1989</td>
<td>Specification for 43 Grade Ordinary Portland Cement</td>
</tr>
<tr>
<td>12269 - 1987</td>
<td>Specification for 53 Grade Ordinary Portland Cement</td>
</tr>
</tbody>
</table>

MATERIALS :

Cement :

Unless otherwise indicated, cement used shall be Ordinary Portland Cement 43 grade confirming to IS 8112 of approved make. Use of any other grade of cement incase of extreme emergency shall be with the specific approval from the consultant and Engineer – in – Charge. Cement older than 3 months from the date of manufacturing shall not be used for the work.

Storage:

Cement in bags shall be stored in dry waterproof sheds to protect the cement from dampness and to minimize warehouse deteriorations. Where cement has been stored and for any reason the stored cement shows signs of deterioration or contamination, it may be tested before use for its strength, setting time, etc., cement which has fully or partially set shall not be used.

Storage of cement at the site of work shall be at the contractor's expense and risk. In the event of any damage occurring to cement due to faulty storage in contractor's sheds or on account of negligence on his part, such damage shall be the liability of the contractor. The storage shall be planned considering optimum utilization as per planned progress and shall not allow storage of cement for longer period than the specified.

Precautions in storage:
Cement bags shall not be piled against the wall. A space of 60 cm all round shall be left between the walls and the piles, bags shall be piled off the floor on wooden planks. Bags shall be kept close together in the pile to reduce circulation of air as much as possible and shall not be piled more than 10 bags high to avoid lumping under pressure. The width of pile shall not be more than about 3m. For extra safety during the monsoon, or when it is expected to store the cement for an unusually long period, the pile shall be completely enclosed by a waterproof membrane such as polythene, tarpaulin etc. Each consignment of cement shall be stacked separately to permit easy access for inspection and facilitate removal. Cement shall be used in the order in which it is received.

### Aggregates from Natural Sources:

#### Quality of Aggregates:

Aggregates from natural sources shall consist of (crushed or uncrushed) stones, gravel and sand or combination thereof conforming to IS 383. Specification for coarse and the fine aggregates from natural sources used for concrete. They shall be hard, strong, dense, durable, clean and free from veins and adherent coatings and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky and elongated pieces shall be avoided. Aggregated shall be obtained from approved sources as indicated.

Coarse aggregates shall be obtained from crushed granite, trap, basalt or similar stones from approved quarry. Sampling and testing shall be as per IS : 2386.

#### Deleterious Materials:

Aggregates shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, organic impurities, soft fragments, sea shells, etc., in such quantities as to affect the strength or durability of the concrete. Aggregates to be used for reinforced concrete shall not contain any material liable to attack the steel reinforcement. Aggregates, which are chemically reactive to alkalis in cement, shall not be used in cement concrete.

#### Limits of Deleterious Materials:

The maximum quantities of deleterious materials in the aggregates shall not exceed the limits laid down in IS 383.

4.3.3.1 If the quantities of deleterious materials in the aggregates exceed the limits mentioned above the aggregates shall be washed in fresh and clean water to the satisfaction of E.I.C before use.

4.3.3.2 Use of sea-sand shall not be allowed for any description of mortar and concrete works, in any location.

#### Aggregate Crushing Value:

The aggregate crushing value shall not exceed 45 percent for aggregate used for concrete other than for wearing surfaces and 30 percent for concrete for wearing surfaces such as runways roads and pavements.

#### Aggregate Impact Value:

As an alternative to aggregate crushing value, the aggregate impact value shall not exceed 45 percent by weight for aggregates used for concrete other than for wearing surfaces and 30 percent by weight for concrete for wearing surfaces, such as runways roads and pavements.

#### Aggregate Abrasion Value:

The abrasion value of aggregate, using Los Angles machine shall not exceed the following value:

a) For aggregates to be used in concrete for wearing surfaces-30 percent

b) For aggregates to be used in other concrete-50 percent

#### Size and Grading of Aggregates:
### OF COARSE AGGREGATE:

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage Aggregate</th>
<th>Passing for graded of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>40 mm</td>
</tr>
<tr>
<td>80 mm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>63 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40 mm</td>
<td>95-100</td>
<td>100</td>
</tr>
<tr>
<td>20 mm</td>
<td>30-70</td>
<td>95-100</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10 mm</td>
<td>10-35</td>
<td>25-55</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>0-5</td>
<td>0-10</td>
</tr>
</tbody>
</table>

### GRADING OF FINE AGGREGATE:

(2) Fine Aggregate (Sand): The grading of fine aggregates shall be within the limits given in the following table and shall be described as fine aggregates Grading zone I, II, III & IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 micron I.S. Sieve, by a total amount not exceeding 5 percent, it shall be regarded as falling within that Grading Zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. Sieve or to percentage passing any other size on the coarser limit of grading Zone I or the finer limit of Grading Zone IV.

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading I</td>
</tr>
<tr>
<td>10 mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
</tr>
<tr>
<td>600 micron</td>
<td>15-34</td>
</tr>
<tr>
<td>300-micron</td>
<td>5-20</td>
</tr>
<tr>
<td>50 micron</td>
<td>0-10</td>
</tr>
</tbody>
</table>

**NOTE 1:** For crushed stone sands the permissible limit on 150 micron I.S. Sieve shall be increased to 20 percent. This does not affect the 5 percent allowance, as already permitted, applicable to other sieve sizes.

**NOTE 2:** Fine aggregate conforming to Grading Zone IV shall not be used in reinforced concrete, unless tests (which shall be recorded) have been made to ascertain the suitability of proposed mix proportions and prior written approval of EIC for use of such fine aggregate is obtained.

(3) All-in Aggregate: Grading of all in aggregate shall be within the limits given in the following table:

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing for All-in-Aggregate of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 mm</td>
</tr>
<tr>
<td>80 mm</td>
<td>100</td>
</tr>
<tr>
<td>40 mm</td>
<td>95-100</td>
</tr>
<tr>
<td>20 mm</td>
<td>45-75</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>25-45</td>
</tr>
<tr>
<td>600 micron</td>
<td>8-30</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-6</td>
</tr>
</tbody>
</table>
NOTE: For carrying out tests on all-in-aggregates, the fractions passing through 4.75 mm IS sieve and the fractions retained on 4.75 mm IS sieve shall be first separated and there shall comply with the requirements (except grading) specified for fine aggregates and coarse aggregate respectively.

44 Water Proofing Compound:

Integral cement waterproofing compound where indicated shall be used and the same shall confirm to the requirements of IS 2645-1975. Specifications for integral cement water proofing compound or as specified in the BOQ.

45 Water:

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, 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 6. Potable water is generally considered satisfactory for mixing concrete.

Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

WORKMANSHIP

4.6 Plain and Reinforced Cement Concrete:

4.6.1 Cement Concrete:

Cement concrete shall be of the specified Grade or volumetric mix as indicated. Cement concrete and reinforced cement concrete shall be provided in accordance with IS 456-2000, code of practice for plain and reinforced concrete, except as otherwise stated.

4.6.2 Concrete Mix Proportioning:

Where concrete is specified by its Grade i.e., characteristic compressive strength, determination of proportions of cement, aggregates and water to attain the required strength shall be made by designing the concrete. Mix (Design mix concrete).

Design Mix Concrete:

The mix shall be designed to produce the grade of concrete having the required workability and the characteristic strength not less than that specified. The contractor shall conduct all necessary tests and analysis of the materials and provide necessary test/analysis data required for design of the concrete mix. The contractor shall also make trial mixes of concrete and conduct necessary tests to arrive at the approved mix proportioning and strength at his cost. As long as the quality of materials does not change a mix design done earlier may be considered adequate for later work. The mix design shall be done/tested from the Government Laboratories preferably located at NASIK.

4.6.2.1 MINIMUM CEMENT CONTENTS:

Volumetric Mix Concrete:

Where indicated concrete will be of the specified volumetric mix. For volumetric mix concrete, the proportions of cement and aggregates are defined by bulk. Volumetric mix shall be designated as 1:4:8, 1:3:6 etc., the figures denote the relative proportions of cement, fine aggregate in dry condition and graded coarse aggregate respectively. If fine aggregate is moist, necessary allowance shall be made for bulking. To determine bulk, 50 kg of cement shall be taken as equal to 0.035 cum. Quantities of fine and coarse aggregates shall be determined by Volume separately and accurately in proper gauge boxes. The gauge boxes shall be of such dimensions that 50 kg of cement forms a unit. The equivalent size of a box for 50 kg cement bag will measure 40x 35x 25 cm internally. Consolidation of aggregates in the gauge boxes by ramming or shaking shall not be allowed.
4.6.3 Batching:

In proportioning design mix concrete, the quantity of both cement and aggregates shall be determined by weight. Water shall be either measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked. All materials for controlled concrete shall be batched as per approved design in suitable weigh batcher of adequate capacity and of approved design.

4.6.3.1 The material shall be stockpiled for several hours, preferably a day before use. The grading of coarse and fine aggregates shall be checked as frequently as possible, the frequency for a given job being determined by the EIC to ensure that the specified grading is maintained.

4.6.3.2 Where the aggregates supplied are not graded, different sizes shall be blended in right proportions; the different sizes being stacked in separate stock piles.

4.6.3.4 Water cement ratio shall be maintained at its correct value.

4.6.3.5 No substitutions in the materials used on the work or alterations in the established proportions shall be made without additional test to show that the quality and strength of concrete are satisfactory.

4.6.4 Workability of concrete:

The concrete shall be of adequate workability for the placing condition of the concrete and proper compactions with the means available. Suggested ranges of values of workability of concrete for some placing conditions, measured in accordance with IS 1199-1959, are given below:

<table>
<thead>
<tr>
<th>Placing conditions</th>
<th>Degree of workability</th>
<th>Values of Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Concreting of shallow sections with vibration</td>
<td>Very low</td>
<td>20-10 seconds vee-bee time OR 0.75-0.80 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly Low reinforced sections with vibration</td>
<td>Low</td>
<td>10-5 seconds vee-bee time OR 0.80-0.85 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly reinforced sections without vibration, or heavily reinforced section with vibration</td>
<td>Medium</td>
<td>5-2 seconds vee-bee time OR 0.85-0.92 compacting factor OR 6-25mm slump for 12.5 mm aggregate OR 25-75mm slump for 20 mm aggregate</td>
</tr>
<tr>
<td>Concreting of heavily reinforced section without vibration</td>
<td>High</td>
<td>Above 0.92 compacting factor OR 75.;125mm slump for 20 mm aggregate</td>
</tr>
</tbody>
</table>

4.6.5 Mixing:

Concrete shall be mixed in a mechanical mixer. The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. If there is segregation after unloading from the mixer, the concrete shall be re-mixed. The mixing time may be taken as 1-1/2 to 2 minutes.

4.6.6 Form Work:

4.6.6.1 General:

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings. All forms shall be sufficiently watertight to prevent leakage of mortar. Forms shall be constructed so as to remove in sections. Formwork shall be provided finished fair and even as specified in section 7-
4.6.6.2 Cleaning and Treatment of Forms:

All rubbish particularly chippings; shavings and sawdust shall be removed from the interior of the forms before the concrete is placed. The formwork in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition to prevent adhesion between formwork and concrete. Care shall be taken that such approved composition is kept out of contact with the reinforcement.

4.6.6.3 Stripping Time:

Forms shall not be struck until the concrete has attained strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions of temperature and moisture similar to those existing of the work. Where so required formwork shall be left longer. In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods: For other cement stripping time shall be indicated:

| (a) | Walls, columns and vertical faces of all structural members | 2 days |
| (b) | Slabs (props left under) | 3 days |
| (c) | Beam Soifts (props left under) | 7 days |
| (d) | Removal of props under slabs |
| | (1) Spanning up to 4.5 m | 7 days |
| | (2) Spanning over 4.5 m | 14 days |
| (e) | Removal of props under beams and arches |
| | (1) Spanning up to 6 m | 14 days |
| | (2) Spanning over 6 m | 21 days |

In case of bad weather these periods may be increased at the direction of EIC.

The number of props left under, their sizes and disposition shall be such as to be able to safely carry the dead load of slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

4.6.6.4 Removal of Form work:

Formwork shall be removed in such a manner as would not cause any shock or vibration that would damage the concrete. Before removal of soffits and props concrete surface shall be exposed to ascertain that the concrete has sufficiently hardened.

4.6.6.5 Where the shape of the element is such that formwork has re-entrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

REINFORCEMENT:

4.6.7 Assembly of Reinforcement:

Reinforcement shall be bent and fixed as specified in section 10 Steel and Iron work. All reinforcement shall be placed and maintained in the position shown in the drawings during concreting. Crossing bars shall not be tack welded for assembly of reinforcement, unless otherwise indicated. All Reinforcement shall be of tested Quality and specified Diameter as per the design. Test reports shall be submitted to Engineer – in – Charge / Consultant for approval.

4.6.7.1 Tolerance on Placing of Reinforcement:

Unless otherwise directed, reinforcement shall be placed within the following tolerance:

(a) For effective depth 200 mm or less + 10 mm

(b) For effective depth more than 200 mm + 15 mm
6.7.2 Welded joints or mechanical connectors:

Welded joints in reinforcement may be used where indicated / directed but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of the bars connected.

4.6.8 Cover to Reinforcement:

4.6.8.1 Reinforcement shall have concrete cover and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as follows, unless otherwise indicated:

a) At each end of reinforcing bar, not less than 25 mm or less than twice the diameter of such bar;

b) For a longitudinal reinforcing bar in a column not less than 40 mm nor less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under whose reinforcing bars do not exceed 12 mm, a cover of 25 mm may be used;

c) For longitudinal reinforcing bar in a beam, not less than 25 mm nor less than the diameter of such bar;

d) For tensile, compressive, shear, or other reinforcement in a slab, not less than 15 mm nor less than the diameter of such bar; and

e) For any other reinforcement, not less than 15 mm nor less than the diameter of such bar.

4.6.8.2 Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals acid vapour, saline atmosphere sulphurous smoke, etc., and such increase of cover may be between 15mm and 50mm beyond that specified in 4.6.8.1, as indicated.

4.6.8.3 In all cases the cover shall not exceed 75 mm.

4.6.9 Transporting:

Concrete shall be transported from the mixer to the formwork as rapidly as possible by methods, which will prevent the segregation or loss of any of the ingredients and maintaining the required workability. During hot or cold weather, concrete shall be transported in deep containers.

Other suitable methods like transporting by transit mixers may be adopted. Special care should be taken to reduce loss of water by evaporation in hot weather and heat loss in cold weather during transportation. Sufficient numbers of transit mixtures shall be employed for maintaining continuity of concreting process.

Concrete line-pumps of suitable capacity and sufficient numbers shall be engaged for pouring concrete in pavements.

4.6.10 Placing:

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. Methods of placing should be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of formwork. The concrete, which is deposited or otherwise disturbed after initial setting commences shall be immediately removed from the site.

4.6.10.1 Before placing the concrete in trenches or on sub-grade or sub-base, the sub-grade / sub-base shall be cleaned of all injurious or foreign matter, watered and well consolidated, if necessary.

4.6.10.2 The final layer of concrete shall be laid to such levels and falls as may be directed.

4.6.10.3 When concrete has to be lowered to any depth below 15m, it shall be conveyed in suitable receptacles or by chute. The delivery end of the chute shall be as close as possible to the point of deposit. The chutes shall be thoroughly flushed with water before and after each working period, the water for this purpose shall be -discharged outside the formwork.

4.6.11 Compaction:
Concrete shall be thoroughly compacted and, fully worked around the reinforcement, around embedded fixtures and into the corners of the formwork. Mechanical vibrators shall be employed for compacting concrete. Over vibration or vibration of very wet mixes is harmful and shall be avoided; under vibration is also to be avoided. Sufficient numbers of reserve / vibrators in good working condition shall be kept at all times so as to ensure that there is no slacking / interruption in compacting. Vibrators of specified sizes shall be used depending upon the quantum of concreting.

4.6.11.1 Where vibration is to be applied externally, the design of formwork and the disposition of vibrators shall be such as to ensure efficient compaction and to avoid surface blemished.

4.6.12 Construction Joints:

Concreting shall be carried out continuously up to construction joints the position and arrangement of which shall be as indicated or directed by the consultant and Engineer – in – charge.

4.6.12.1 When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints neat cement slurry at the rate of 2.50 kg of cement per sqm shall be applied on the surface before it is dry. For horizontal joints surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand ratio as the cement and sand in the concrete mix. The layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing of concrete.

4.6.12.2 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes. Care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surfaces shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150mm in thickness shall first be placed and shall be well rammed against old work; particular attention being paid to corners and close spots; work thereafter shall proceed in the normal way.

4.6.12 Curing:

Exposed surfaces of concrete shall be kept continuously in. a damp or wet condition by covering with a layer of sacking, canvas, Hessian or similar materials or a layer of sand or by ponding for at least seven days from the date of placing of concrete. Approved curing compounds may be used in lieu of moist curing with the permission of EIC. Such compounds shall be applied to all exposed surface of the concrete as soon as possible after the concrete has set.

4.6.13 Protection:

The concrete shall be carefully protected after it is laid against the action of frost and shielded from exposure to sun to avoid rapid drying. Care shall be taken to protect the concrete from all shaking and other disturbances during construction. No traffic shall be allowed on the finished concrete surface for at least 7 days. This period may be increased or decreased at the discretion of EIC.

4.6.14 Inspection :

Immediately after stripping the formwork, all concrete shall be carefully inspected for any defective work and defects either removed or made good before the concrete has thoroughly hardened.

4.6.15 Exposed Surfaces :

4.6.15.1 The contractor shall use proper formwork so that the concrete in contact with removal of formwork present an even surface. Concrete while being poured against formwork shall be adequately tamped, or vibrated where directed, so that fines are drawn towards the surface and honeycombing is avoided.

4.6.15.2 Exposed surfaces of concrete shall be “Finished fair and Even in Forms”.

Exposed surfaces after striking off formwork shall be such as to present a fair and even surface and shall not be plastered unless otherwise specified. The surface shall be presentable without any further treatment.

Any irregularities and protruding formwork marks shall be removed and minor honeycombing made good with cement and sand mortar 1:3. Lines along the formwork joints may however show.
6.15.3 Exposed surfaces of concrete which are indicated/required to be plastered shall be roughened with wire brushes and hacked out closely immediately after removal of formwork.

4.6.15.4 Openings and Inserts:

Openings and Positions of Inserts shall be made as per the drawing or as directed by the Consultant and EIC. This shall be done with utmost accuracy/precision and any deviation from the Drawing or instruction by the Consultant or EIC, the same shall be rectified by the Contractor at his own cost. No Extra payment shall be admissible for making openings/inserts etc.

4.6.16 Sampling and testing of concrete:

Samples from fresh concrete shall be taken as per IS 1199-1959. Method of sampling of concrete and cubes shall be made, cured and tested at 28 days in accordance with IS 516-1959, Method of test for strength of concrete.

4.6.16.2.1 Where indicated, tests on beams for modulus of rupture at 72 ± 2hrs or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength alone shall be the criterion for acceptance or rejection of the concrete.

4.6.16.3 Test Specimen:

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for such purpose as to determine the strength of concrete at 7 days or to check the testing errors.

4.6.16.4 Test Strength of samples:

The test strength of the sample shall be the average of the strength of three specimen. The individual variation shall not be more than +/- 15 percent of the average.

4.6.16.5 Acceptance Criteria:

The concrete shall be deemed to comply with the strength requirement when both the following conditions are met:

a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in Column No. 2 Table –11 of IS 456 -2000

b) Any individual test results complies with the appropriate limits in column No.3 of Table -11 of IS 456-2000.:

If the concrete is deemed not to comply pursuant to acceptance criteria, it shall be dismantled and redone at the contractor's expenses.

Concrete of each grade shall be rejected if it is porous or honey-combed: its lacing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-charge

4.6.16.5 Standard Deviation:

Standard deviation of concrete of each grade shall be determined separately as stated below. When result of sufficient number of tests (at least 30) are not available, than depending on the degree of quality control expected to be exercised at the site, the value of standard deviation given in the following table may be adopted for guidance. Grade of Concrete Suggested Values of S.D

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>S.D. for different degree of control in N/mm2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Good</td>
</tr>
<tr>
<td>M 10</td>
<td>2</td>
</tr>
<tr>
<td>M 15</td>
<td>2.5</td>
</tr>
<tr>
<td>M 20</td>
<td>3.6</td>
</tr>
<tr>
<td>M 25</td>
<td>4.3</td>
</tr>
<tr>
<td>M 30</td>
<td>5</td>
</tr>
<tr>
<td>M 35</td>
<td>5.3</td>
</tr>
<tr>
<td>M 40</td>
<td>5.6</td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 44 of 494
47  **Waterproof Concrete:**

Where indicated, cement concrete shall be waterproofed by adding integral waterproofing compound conforming to IS 2645-1975, Specification for integral cement waterproofing compounds at the time of making concrete as per the manufacturer's instructions. The quality of waterproofing compound shall be as indicated but in no case shall be less than the quality recommended by the manufacturers and not exceeding 3 percent by weight of cement.

48  **Work in Extreme Weather Concreting:**

Concreting during hot and cold weather shall be done as per the procedures set out-in IS: 7861 (part-I) Code of practice for extreme weather concreting; part I Recommended practice for hot weather concreting, or IS7861 (part-II)-1981 Code of practice for extreme weather concreting; Part II Recommended practice for cold weather concreting.

49  **Reinforced Concrete Work in Water Retaining Structure:**

4.9.1 Special care shall be taken to get the most suitable grading of aggregate so as to produce the densest possible concrete. Mix proportion shall be indicated. Water cement ratio shall be controlled consistent with the requirements of workability to produce impervious concrete.

4.9.2 The concrete between the reinforcement and the formwork on the water face shall be well compacted and the board joints tight, so as to produce a face free from honey-combing or pores. External vibrators viz. shutter vibrators at the rate of one vibrator per 2.5 m² of shutter area shall be used to produce a compact concrete with a dense skin which shall not, however, contain an excess of cement, wherever it is not possible to use shutter vibrator, pin vibrator shall be used after the approval of EIC.

4.9.3 **Construction, Contraction & Expansion Joints.**

4.9.3.1 All vertical, horizontal construction and expansion joints in water retaining structures shall be located and executed as shown in the drawings and no deviation shall be permitted without the specific permission of EIC. Where days' work joints are formed whether horizontally or vertically, they shall be rebated as called out on drawings. Care shall be taken to remove from the earlier lift over all loose pieces of gravel, stone chips, wooden chips, country nails or any other foreign materials. All laitance shall also be thoroughly removed. If necessary, the face of the old concrete shall be well hacked to expose the aggregate and after washing the surface, a thin coat of mortar or grout (1 cement: 1 sand) shall be applied immediately before resuming concreting.

4.9.3.2 Water bar installation along the joints shall be done by embedding one half of the water bar in each side of the joint by suitable jigs / supporting arrangements between the adjacent sections of the concrete as per the manufacturer's specifications and directions of the EIC. Water bars shall be properly aligned and placed in position during embedding. To achieve the continuity of the water bar all along the joint at crossing and at change of alignment, the water stops shall be welded (in T,X or L shapes as the case may be) as per manufacturer's specifications and directions of EIC. Suitable jigs manufactured out of reinforcing bars may be used for fixing the water bars.

4.9.3.3 **Fittings:**

Pipes and outer fittings passing through the walls and bottom shall be well embedded in the concrete and shall be provided with normal puddle flanges. Opening in the walls, and floor slabs if any shall be provided as per the relevant drawings.

4.9.4 **Curing :**

Concrete in water retaining portion shall be cured minimum for 21 days.

4.9.5 **Hydraulic Testing:**

Structures shall be tested strictly in accordance with IS: 3370 (Part I) for water tightness. For underground tank, the total maximum drop in water surface level over seven days shall not exceed 40 mm.
10 Pre-cast Reinforced Concrete-Generally

4.10.1 Pre-cast reinforced concrete articles such as manhole cover and frame, columns, fencing posts, door and window frames, lintels, chajjas, copings, sills, shelves, slabs, louvers etc. shall be of the grade or mix as indicated and cast in forms or moulds. The forms shall be of timber or of steel for better finish. Provisions shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. The contractor may precast the units on cement or steel platform that shall be adequately oiled provided the surface finish is of the same standard as obtained in the forms. Each unit shall be cast in one operation.

4.10.2 Concrete shall be proportioned, mixed, placed and thoroughly compacted by vibration or tamping to give a dense concrete free from voids and honeycombing.

4.10.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have no cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units or to impair the strength or the performance of construction. All angles of the precast units with the exception of the angles resulting from the splayed or the chamfered faces shall be true right angles. The rises shall be clean and sharp except those specified to be rounded. The wearing surface shall be true and out of winding. On being fractured, the interior of the units shall present a clean, homogeneous appearance.

4.10.4 The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed.

4.10.5 Curing:

After placing, the concrete shall be adequately protected during setting and in first stages of hardening from shocks and from the harmful effects of sunshine, drying winds and cold. The concrete shall be cured for at least 7 days.

4.10.6 Maturing:

From the date of casting, the precast articles shall be matured for 28 days before erection or being built up.

4.10.7 Concrete shall have sufficient strength to prevent damage to units when first handled.

Flyash:

Addition of flyash may be considered to the extent of 10% only and not more for footings, pedestals, columns, slabs and beams. Flyash shall not be used for Pavements and floors.

Nevertheless of what is specified herein above or not, IS – 456,516,10262 and 1199 shall be followed related to all the matters of concrete specified therein.

4.10.8 Marking:

Precast articles shall be clearly marked to indicate the top of member and its location and orientation in the structure. While the concrete is still green, each unit shall be marked with the date of casting. Precast units shall be stored, transported and placed in position in such a manner that they will not be over stressed or damaged.

4.11 Epoxy resin concrete bonding agent

Scope of work.

For bonding new cementitious materials to existing cementitious surfaces. For use on horizontal surfaces and on vertical surfaces where mortar or concrete can be supported by formwork. Where extension to existing structure or similar work is ordered. The following strengths should be achieved as Per table below:

| Compressive Strength BS 6319 Pt - 2 | @ 7 days | 50 N/mm² |

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Flexural strength BS 6319 Pt 3 @ 7 days 35 N/mm²

Tensile strength BS 6319 Pt 7 @ 7 days 20 N/mm²

Shear strength BS 6319 Pt 4 @ 7 days 10 N/mm²

Adhesive strength to concrete: In general the bond strength will always exceed the tensile strength of M30 concrete.

The Tests shall be carried out at manufacturers laboratory and results shall be submitted to the consultant / EIC for approval

**Specification clauses**

The bonding agent shall be an epoxy based two component resin system pre packed in distinct colours to give visual evidence for proper mixing. The bonding agent should remain in tacky state after application for a minimum period of 6 hours at 30°C. There shall not be bond failure of the specimen when tested by slant shear method according to BS 6319 pt 4.

**Application instructions**

**Preparation**

All surfaces to be treated must be firm, dust free and clean. All laintence should be removed by etching with Reebakens and wire-brushing. Where ever necessary, the existing concrete must be chipped to a sound substrate. Where surfaces are contaminated with oil or grease, this should be removed by using a strong industrial detergent or organic degreaser. Surface should be washed thoroughly with water and dried before the application.

**Mixing**

The entire contents of the hardener shall be poured into the resin container and the two materials thoroughly mixed until a uniform colour is obtained. To facilitate application at temperatures below 10 °C the separate components should be warmed in hot water to a maximum of 25 °C before mixing.

**Coating**

Mixed Epoxy resin bonding agent should be brush applied to the prepared surface. The new concrete should be placed within 6 hours at 30°C to the coated substrate, when it is in a tacky state.

**Rate**

The rate shall include the cost of all labour and materials involved in all the above operations and testing (including surface preparation) described above. No Extra Payment shall be made for Testing.

4.12 **High strength, non-shrink, cementitious grout**

**Description of work:** It is used for grouting of base plates of Columns, stanchions, and similar applications etc.,

**Description of material:** This material is supplied as a ready to use dry powder. The addition of a controlled amount of clean water produces a free flowing, non-shrink grout for gap thicknesses up to 100mm.

This material is a blend of Portland cement, graded fillers and chemical additives which impart controlled expansion in the plastic state whilst minimizing water demand. The low water demand ensures high early strength. The graded fillers are designed to assist uniform mixing and produce a consistent grout.

The Tests shall be carried out at at approved Govt. laboratory and results shall be submitted to the consultant / EIC for approval

**Specification Clauses**
Performance specification

All grouting shown on the drawing must be carried out with a pre-packed cement based product which is chloride free. It shall be mixed with clean water to the required consistency. The grout must not bleed or segregate. A positive volumetric expansion shall occur while the grout is plastic by means of gaseous system. The compressive strength of the grout must exceed 50 N/mm$^2$ at 7 days and 60 N/mm$^2$ at 28 days as per Code (BS 1881 - Part 116: 1983). The flexural strength of grout must exceed 9N/mm$^2$ @ 28 days as per Code (BS 4551, 1998). The fresh wet density of the mixed grout must exceed 2150 kg/m$^3$.

The storage, handling and placement of the grout must be in strict accordance with the manufacturer's instructions.

Application instructions

Preparation Foundation surface

The substrate surface must be free from oil, grease or any loosely adherent material. If the concrete surface is defective or has laitence, it must be cut back to a sound base. Bolt holes and fixing pockets must be blown clean of any dirt or debris.

Pre-soaking

Several hours prior to placing, the concrete substrates should be saturated with fresh water. Immediately before grouting takes place any free water should be removed with particular care being taken to blow out all bolt holes and pockets.

Base plate

It is essential that this is clean and free from oil, grease or scale. Air pressure relief holes should be provided to allow venting of any isolated high spots. Leveling shims if these are to be removed after the grout has hardened, they should be treated with a thin layer of grease.

Formwork

The formwork should be constructed to be leak proof. This can be achieved by using foam rubber strip or mastic sealant beneath the constructed formwork and between joints. In some cases it is practical to use sacrificial semi-dry sand and cement formwork. The formwork should include outlets for pre-soaking.

Unrestrained surface area

This must be kept to a minimum. Generally the gap width between the perimeter formwork and the plate edge should not exceed 150mm on the pouring side and 50mm on the opposite side. It is advisable, where practical, to have no gap at the flank sides.

Mixing and placing

Mixing

For best results a mechanically powered grout mixer should be used. When quantities up to 50kg are used, a heavy duty slow speed drill (400-500 rpm) fitted with a paddle is suitable larger quantities will require a heavy duty mixer.

To enable the grouting operation to be carried out continuously, it is essential that sufficient mixing capacity and labour are available. The use of a grout holding tank with provision to gently agitate the grout may be required.

Consistency of grout mix

The quantity of clean water required to be added to a 25kg bag to achieve the desired consistency as given in table below:
Placing

At 30°C place the grout within 20 minutes of mixing to gain full benefit of the expansion process. Grouting material can be placed in thicknesses up to 100mm in a single pour when used as an under plate grout.

For thicker sections it is necessary to fill out grouting material with well graded silt free aggregate to minimize heat buildup. Typically a 10mm aggregate is suitable. 50 - 100% aggregate weight of grouting material can be added.

Rate

The rate shall include the cost of all labour and materials involved in all the above operations and testing as described above. No Extra Payment shall be made for Testing.

BATCH MIXING PLANT

Central Mixed Concrete Batching Plant specified capacity in General Conditions of Contract (Volume I) shall be set up by the contractor.

4.13 READY MIX CONCRETE

(IF SPECIFICALLY PERMITTED BY ENGINEER IN CHARGE ON EMERGENCY)

SPECIFICATIONS for RMC:

Contractor shall make ready mixed concrete with who is expert in the field, would supply designed mix. The RMC producer accepts the responsibility for the design of the mixture for the desired performance. The contractor shall specifies aggregate size, slump, air content, cement content, or weight of cement per cubic meter of concrete, maximum water content and admixtures required. The contractor shall accept the responsibility for concrete strength and its performance.

PROPORTIONING OF RMC:

The proportioning of an RMC aims at obtaining the properties, such as workability, strength, durability and appearance. The following basics of a good concrete mix should be considered while proportioning RMC Concrete aggregates should be clean, strong and durable. Fly ash or other supplementary cementitious materials added as directed if necessary by EIC to RMC to enhance concrete properties. Admixtures are commonly used to improve the rate of setting and strength of development of concrete as directed by EIC.

CENTRAL- MIXED CONCRETE:

Concrete batch plants include a stationary, plant mounted mixer that mixes the concrete before it is discharged into a truck mixer. While traveling to the job site the drum is turned at agitating speed (slow speed). After arriving at the job site, the concrete is completely mixed. The drum is then turned for 70 to 100 revolutions, or about 5 minutes, at mixing speed. Concrete mixed in the yard or central batching plant: The drum is turned at high speed or 12-15 rpm for 50 revolutions. This allows quick check of batch. The concrete is then agitated slowly while driving to the job site. Concrete mixed in transit: The drum is turned at medium speed or about 8 rpm for 70 revolutions while driving to the job site.

DELIVERY OF RMC:

Ready mix concrete can be delivered to the construction site in truck mounted, rotating drum mixers. Truck mixers have a revolving drum with the axis inclined to horizontal. To load or charge the raw materials from a transit mixed plant or central mixed plant into the truck, the drum must be turned very fast in the changing direction. After the concrete is loaded and mixed, it is normally hauled to the job site with the drum turning at the speed of less than 2 rpm. The truck mixer shall have discharge units to convey through the pump to desired location in the site.
IN SPECTION AND TESTING:

Specific control tests and evaluations are required during the manufacturing process to produce predictable high quality concrete. The concrete shall undergo all the specified test for concrete as per IS codes.

4.14 Plasticizer

Scope of work
To produce high workability concrete without loss of strength and to promote high early and ultimate strengths by taking advantage of water reduction whilst maintaining workability. To produce high quality concrete of improved durability and impermeability. At higher dosages, advantages can be taken of the retardation of initial setting time of concrete especially in large pours.

Standards compliance

Plasticizer should conform to IS: 9103-1999 and carries license from Bureau of Indian Standards. It should comply with IS 2645: 1975 and BS 5075 Part 3 and ASTM C494 Type F and chloride content should be nil as per IS 456

Description of material

Plasticizer is based on a blend of specially selected organic polymers and disperses the cement particles effectively in the concrete mix and hence exposes a larger surface area to the hydration process. This effect is used either to increase the strength or to produce high workability concrete or reduce cement content of concrete or to retard the setting time of concrete

Application instructions

Application process as per manufacturer’s specifications and contractor should submit the technical literature & get approval from the EIC and the material should be used within the shelf time.

SECTION-5

BRICK WORK

5.1 Indian standards

The following IS with latest revision apply to this section:

<table>
<thead>
<tr>
<th>LS. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>195-1963</td>
<td>Specification for fire clay mortar for laying fire clay refractory bricks (second revision)</td>
</tr>
<tr>
<td>702-1988</td>
<td>Specification for industrial bitumen (second revision)</td>
</tr>
<tr>
<td>1077-1986</td>
<td>Specification for common burnt clay building bricks (fourth reversion)</td>
</tr>
<tr>
<td>1526-1960</td>
<td>Sizes and shapes for fire bricks (230mm. series)</td>
</tr>
<tr>
<td>1580-1969</td>
<td>Specification for bituminous compounds for water proofing and caulking purposes (first reversion)</td>
</tr>
<tr>
<td>1905-1980</td>
<td>Code for practice for structural safety of building masonry wall (second revision)</td>
</tr>
<tr>
<td>2116-1980</td>
<td>Specification for sand for masonry mortars (first revision)</td>
</tr>
<tr>
<td>2386 (Part II) 1963</td>
<td>Methods of test for aggregates for concrete. Part II -Estimation of deleterious materials and organic impurities.</td>
</tr>
<tr>
<td>2691-1988</td>
<td>Specification for burnt clay facing bricks (second revision)</td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL

<table>
<thead>
<tr>
<th>EMPLOYER</th>
</tr>
</thead>
<tbody>
<tr>
<td>4832 (Part II) 1969</td>
</tr>
<tr>
<td>5454-1978</td>
</tr>
</tbody>
</table>
MATERIALS

52 CEMENT

Unless otherwise indicated, Cement shall be Ordinary Portland cement, 43 grade conforming to IS 8112 of approved make/brand. Use of any other grade of cement incase of extreme emergency shall be with the specific approval from the consultant and Engineer – in – Charge.

5.3 DELETED

5.4 Sand for Masonry Mortars

Unless otherwise indicated, sand for mortars shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these conforming to IS 2116-1980:, specification for sand for masonry mortars. Sand shall be hard, durable, clean and free from adherent coatings and shall not contain clay and impurities such as iron pyrites, alkalies, salts, coal, mica, shale or similar laminated or other materials exceeding the specified limits.

5.4.1 The maximum quantities of clay, fine silt and fine dust in sand shall not be more than 5 percent by mass. Organic impurities shall be below that obtained, by comparison with the standard solution specified in 6.2.2 of IS 2386 (Part II)-1963. Method of test for aggregate for concrete, Part II Estimation of deleterious material and organic impurities.

5.5 DELETED

5.6 Common Burnt Clay Building Bricks

5.6.1 Common burnt clay building bricks (hereinafter termed as bricks) shall conform to the requirements laid down in IS 1077 -1992, specifications for Common burnt clay building bricks. The class of bricks (based on minimum average compressive strength) viz 3.5(or35), 5(or50) as mentioned below, shall be as indicated. Bricks shall be neither overburnt nor under burnt and shall be free from cracks, or any other such defects.

5.6.2 Sub Class A bricks shall have smooth rectangular faces with sharp corners and shall be uniform in color. Sub Class ‘B’ bricks may have slight distorted and round edges provided no difficulty arise on this account in laying of uniform courses.

5.6.3 Dimensions: Size of bricks shall be as indicated. Standard of bricks are as under:

5.6.4 Tolerance:

<table>
<thead>
<tr>
<th>Type of Bricks</th>
<th>Nominal Size</th>
<th>Actual Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular Bricks</td>
<td>20x10x10cm</td>
<td>19x9x9 cm</td>
</tr>
<tr>
<td>Old size Bricks(FPS)</td>
<td>9x4.5x3 inches or 23x1 1.3x7.5 cm or 25 x 12.5 x 7.5 cm</td>
<td>9x4-3/8x2-3/4 inches</td>
</tr>
</tbody>
</table>

Tolerance

The permissible tolerance on the dimensions of the bricks, unless otherwise indicated, shall be +/-3 Percent for Sub Class A bricks and +/-8 Percent for Sub Class B bricks. To verify conformity within tolerance limit,

twenty whole bricks selected at random from the stack shall be arranged upon a level surface successively for measuring the length, width and height, in contact with each other and in a straight line.

5.6.5 General Quality:

Bricks may be hand or machine moulded and shall be made from suitable soils. They shall be free from
acks, flaws and nodules of free lime. Bricks of 7.5 and 10 cm thickness (height) shall be moulded with frog 1 to 2 cm deep on one of its flat faces. Bricks of 4 cm or 5 cm height and those by an extrusion process may not be provided with frogs.

5.6.6 Compressive Strength:

The compressive strength of any individual brick shall not fall below the minimum average compressive strength specified for corresponding class of brick.

5.6.7 Water Absorption:

The average water absorption of bricks, after immersion in cold water for 24 hours shall not be more then 20 percent for bricks up to class 12.5 and 15 percent for higher class of bricks.

5.6.8 Efflorescence:

The rating of efflorescence of the bricks shall not be more than moderate (For bricks up to Class 125)

5.6.9 Handling and Storage of Bricks:

Bricks shall not be dumped at site. They shall be stacked in regular tiers on even ground as they are unloaded to minimize breakage and defacement of bricks. Bricks selected for facing and any particular purpose / situation of use shall be stacked separately.

WORKMANSHIP

5.7 Masonry Mortars

5.7.1 Proportioning

Mortars shall be of the mix as indicated. The mixes specified are by volume Mix proportions of cement mortars specified are in the proportions of cement to dry sand. If moist sand is used, necessary allowance shall be made for bulking.

Cement shall be measured by weight. 50 Kg of cement shall be taken as equal to 0.035 cum to determine bulk. The quantity of water to be added to the mortar shall be such that working consistency is obtained. Excess water shall be avoided.

5.7.2 Preparation of Cement Mortar:

Mixing shall be done preferably in a mechanical mixer. If done by hand mixing operation shall be carried out on a clean watertight platform. Cement and sand shall be mixed dry in the required proportion to obtain a uniform colour. The required quantity of water shall then be added and the mortar hoed back and forth for 5 to 10 minutes with additions of water to a workable consistency. In the case of mechanical mixing, the mortar shall be mixed for at least three minutes after addition of water. Cement mortar shall be freshly mixed for immediate use. Any mortar which has commenced to set shall be discarded and removed from the site.

5.7.3 Time of Use of Mortars:

Mortar with cement as an ingredient shall be used as early as possible after mixing, preferably within half an hour from the time water is added to the mix or at the latest within one hour of its mixing. The mixing of mortar shall be planned in such a way that the same is consumed with in half an hour considering the quantum of work and manpower deployment

5.7.4 Workability of Masonry Mortars:

The working consistency of the mortar is usually judged by the worker during application. The water used shall be enough to maintain the fluidity of the mortar during application, but at the same time it shall not be excessive leading to segregation of aggregates from the cement.

5.8 Setting Out

All brickwork shall be set out and built to the respective dimensions, thickness and heights, as indicated.
Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work, overhand work shall not be allowed.

For exposed brick facing double scaffolding having two sets of vertical supports shall be provided. For brickwork, which is to be plastered over, single scaffolding may be provided. In single scaffolding one end of the putlogs shall rest in the hole provided in the header course of brick masonry. Not more then: one header for each putlog shall be left out. Such holes shall not be allowed in the case of pillars or narrow masonry portions between openings which are less than one meter in width or are immediately under or near the structural member supported by the walls. The holes left shall be made good on removal of scaffolding to match with the face work / surrounding area.

5.9.2 Timber or bamboo scaffolds shall be erected in accordance with the provisions contained in IS 3696 (Part 1)-1 987, Safety code for scaffolds and ladders, Part I-Scaffolds, to ensure safety of workman and others. Steel scaffolding shall be erected in accordance with the provisions contained in IS 2750, Specification for steel scaffolding and relevant provisions of IS 3696 (part 1).

5.10 Soaking of Bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. When bricks are soaked, they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt, earth, etc.

NOTE : The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different period and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in the construction work.

NOTE II : If the bricks are soaked for the required time in water that is frequently changed the soluble salts in the bricks will be leached out, and subsequent efflorescence will be reduced.

5.11 Laying

All loose materials, dirt and set lumps of mortar which may be over the surface on which brickwork is to be freshly started, shall be removed with a wire brush and surface wetted slightly. Bricks shall be laid on a full bed of mortar. When laying, the bricks shall be properly bedded and slightly pressed with handle of trowel so that the mortar can get into all the pores of the bricks surface to ensure proper adhesion. All the joints shall be properly flushed and packed with mortar so that no hollow spaces are left. Care shall be taken to see that the required quantity of water is added to the mortar to the mixing platform to obtain required consistency. Addition of water during laying of the course shall not be permitted. In case of walls two brick thick and over, the joints shall be grouted at every course in addition to bedding and flushing with mortar.

5.11.1 While using old size bricks (FPS conventional bricks) top courses of all plinths, parapets, steps and top of walls below roof slab or floor slab shall be laid with bricks on edge, applicable in case of traditional bricks unless directed otherwise. Care shall be taken that the bricks forming top courses and ends of wall are properly keyed into position.

5.11.2 Bricks shall be laid with frog up. However when the top courses are exposed, bricks shall be laid with frog down, care shall be taken to fill the frogs with mortar before embedding the bricks in position.

5.11.3 All quoins shall be accurately constructed and the height of courses checked with storey rods as the work proceeds. Acute and obtuse quoins shall be bonded, where practicable, in the same way as square quoins; obtuse quoins shall be formed with squint showing a three quarter bricks on the other.

5.12 Bond

All bricks work shall be built in English Bond, unless otherwise indicated. Half brick walls shall be built in stretcher bond. Header bond shall be used for walls curved on plan for better alignment. Header bond shall also be used in foundation footings; stretchers may be used when the thickness of wall renders use of headers impracticable. Where the thickness of footings is uniform for a number of courses, the top courses of the footing shall be of headers.
5.12.1 Half or cut bricks shall not be used except where necessary to complete the bond.

5.12.2 Overlap in stretcher bond is usually half bricks and is obtained by commencing each alternate course with a half brick. The overlap in header bond, which is usually half the width of the bricks, is obtained by introducing a three quarter bricks in each alternate course at quoins. In general, cross-joints in any course of brickwork shall, not be nearer than a quarter of bricks length from those in the course below or above it. 

5.13 Uniformity

The bricks work shall be, built in uniform layers; corners and other advanced work shall be raked back. No part of a wall during its construction shall rise more then one meter above the general construction level, to avoid unequal settlement Parts of walls left at different levels shall be properly raked back. Tooothing may be done where future extension is contemplated but shall not be used as an alternative to raking back.

For Half brick partition to be keyed into main walls, indents shall be left in the main walls.

5.14 Alignments and Prepends

The walls shall be taken truly plumb or true to the required batter, where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate courses shall come directly one over the other. (Quoins, jambs, and other angles shall be properly plumbed as the work proceeds. The maximum permissible tolerance in masonry shall be as under:

(a) Deviation from vertical within a storey per 3m height 6mm
(b) Deviation from vertical in the total height of a building 12.5mm

(c) Deviation of bed joints from horizontal
(i) in any length upto 12m 6mm
(ii) in any length over 12m 12.5mm total

5.15 Thickness of Joints

Thickness of joints shall be such that four courses and three joints taken consecutively shall measure as follows unless otherwise specified:
(i) Old size brick -Equal to four times of actual thickness plus 4cm
(ii) Modular brick -Equal to 39 cm

In cases of soakage pits, cesspools, manholes and the like, the thickness of joints upto 15mm may be adopted. Where brick work to match the existing work, the joints shall be of the same thickness as in the existing work.

5.16 Striking Joints

Where no pointing, plastering or other finish is indicated, the green mortar shall be neatly struck flush. Where pointing, plastering or other finish is indicated, the joints shall be squarely raked out to a depth not less than 10mm for plastering and 15mm for pointing.

5.17 Protection against damage

Care shall be taken during construction that edges of jambs, cills, heads etc. are not damaged. In inclement weather, newly built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away.

5.18 Curing
he brick work shall be constantly kept wet for at least seven days.

5.19 Facing

In case of walls one bricks thick and under, at least one face shall be kept even and in 'proper plane, while the other face may be slightly rough. In case of walls more then one brick thick, both the faces shall be kept even and in proper plane.

For exposed brickwork selected brick of the specified class and subclass shall be used for the face work. Where however, use of facing bricks is indicated; brick walls shall be faced with facing bricks. No rubbing down of brick work shall be allowed.

Brick work shall be plastered pointed or otherwise finished, as indicated. Joints of external faces of brick walls in foundation up to 15 mm below ground level and of internal faces of bricks walls in foundation and plinth below sub-floor level shall be struck flush when the mortar is green, as the work processed.

5.20 Cleaning

Face of brickwork shall be cleaned on the same day it is laid and all mortar droppings removed.

5.21 Brickwork Curved on Plan

Brickwork Curved on Plan to a radius exceeding 6m shall be built as described for general brickwork but where the inner radius is 6 meter or less, all courses shall be of header with bricks roughly cut to the radius wedge shaped joints, unless otherwise indicated.

5.22 Architectural features

5.22.1 Architectural brickwork shall be laid integral with brickwork so as to form proper bond with the main work and in such a way that the main structure is not weakened. In corbels, over sailing courses etc. no course shall project more than one fourth of the brick length beyond the course immediately below. In such cases, all bricks shall be laid as headers. The bricks shall be purpose made were specified or cut and dressed to the required shape wherever necessary. Mitres and stops to splayed bull nosed, rebates, etc. shall be provided as required or directed.

5.22.2 In important works a special template (wooden or, steel) shall be prepared as per drawing to guide the laying of bricks in moulded work. Where plastering is specified, the template shall be prepared taking into account the thickness of plaster.

5.23 Half Brick Walls-Reinforced

The bricks shall be laid in stretcher bond in cement and sand mortar (1:4) or as indicated. The reinforcement may be in the form of mild steel flat or round bars or deformed bars as indicated and as described. The diameter of bars or thickness of flats bars shall not exceed 8 mm. In case where the reinforcements cross inside a joint, the diameter/thickness of reinforcement shall not exceed 8 mm. The reinforcement shall be used in every third courses of the brickwork. They shall be securely anchored at their ends where the partitions bond. The inlaid steel reinforcement shall be completely embedded in mortar. Overlaps in reinforcement, if any shall be not less than 30 cm. The cover that is the mortar interposed between the reinforcement bar and brick shall be not less than 6 mm. The mortar covering the direction of joints shall be not less than 15 mm.

5.24 Construction Details

5.24.1 Chases, Rebates, Reveals, etc.:

Chases, Rebates, Reveals, etc., shall be formed in wall as required to receive frames, floors, pipes, conduits, corrugated sheets, etc. as required or indicated.

5.24.2 Beam Filling:

Beam filling shall be executed to the full thickness of the walls by cutting and fittings brickwork around ends of rafters, joists, etc., and leaving air-space where directed and making good in mortar as for adjacent brickwork.
24.3 Bedding Wall Plates, etc.:

Wall plates lintels, templates, cover stones, etc. shall be bedded in the same mortar as for adjacent brickwork unless otherwise indicated and finished to match brickwork. Walls shall be levelled and prepared to receive wall plates, etc., as required.

5.24.4 Fixing of Wooden Frames

Timber doors and windows frame shall be fixed as the brick work proceed without gap between the masonry and the frames. The doors and windows frames may also be fixed in prepared opening at contractor's option. Fixing shall be done generally with hold fasts securely embedded in the brick work. The chases shall later be filled up with cement and sand mortar (1:3) or concrete (1:2:4) type B-O in case of bigger chases. Hold fasts shall be fixed in the brick work for the specified length and then turned up at the end into a cross joint. Hold fasts shall be given with protective coat of bitumen to avoid rusting. Wooden faces in contact with brick work shall be treated with good preservative as indicated.

5.24.5 Fixing of Metal Frames:

Metal frames shall be fixed into prepared openings and not built in as the walls go up. Steel doors and windows shall be fixed in the openings as described in "Steel and Iron work".

5.24.6 Holes for pipes etc:

All necessary holes for pipes, air flues, ventilators, etc. and mortices, where required for dowels, bolts, etc., shall be cut or formed as work proceeds and grouted in cement and sand mortar 1:3 or cement concrete 1:2:4 as required and made good.

5.24.8 Provision for Services Installations:

To facilitate taking service lines later without in-ordinate cutting of completed work, sleeves and chases shall be provided during the construction itself.

5.24.9 Fastening and Fixing stocks:

All holdfasts, securing bolts and other fixings for fittings etc., shall be securely built in as the work proceeds. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

5.24.10 Bearing of Floors, Roofs, etc:

Tops of walls bearing the edges of RCC floors, roof slabs, beams or lintels shall be finished with a layer of cement mortar (1:4), 15 mm thick and the plastered surface while washed; unless otherwise indicated. Where the bottom of slab does not coincide with the level of brick course after cement plaster, the level shall not be made up with cut bricks. The gap shall be made-up either by increasing the thickness of slab at bearing or where feasible by using brick tiles, so that the bearing is directly on the plaster layer.

SECTION- 6

STONE MASONRY

6.1 Indian Standards: -The following Indian Standards with latest revision apply to the section.
6.2 Stones

6.2.1. The stone shall be of the type such as granite, trap, basalt, or similar approved stones and shall be obtained from the approved quarries. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaw, sand holes injurious veins patches of loose or soft materials and other similar defects that may adversely effect its strength and appearance. As far as possible, stone shall be uniform color and texture. Generally stone shall not contain cryptocrystalline silica or chest, mica and other deleterious materials like iron oxide, organic impurities, etc.

In the case of stratified rocks stone for building purposes shall be so quarried and dressed that when set in the building, the. Stones are laid along the plane of stratification.

6.2.3. The compressive strength and water absorption of common type of stones are given in the table below:

<table>
<thead>
<tr>
<th>Type of Stone</th>
<th>Water absorption, percentage by weight, Max</th>
<th>Compressive Kg / sq cm Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>0.5</td>
<td>1000</td>
</tr>
<tr>
<td>Basalt</td>
<td>0.5</td>
<td>400</td>
</tr>
<tr>
<td>Lime Stone</td>
<td>0.15</td>
<td>200</td>
</tr>
<tr>
<td>Sand Stone</td>
<td>2.5</td>
<td>300</td>
</tr>
<tr>
<td>Marble</td>
<td>0.40</td>
<td>500</td>
</tr>
</tbody>
</table>

NOTE 1: Test for compressive strength shall be carried out as laid down in IS: 1121 (Part 1)-1 974 Method of test for determination of strength properties of natural building stones Part-I Compressive strength (first revision).

NOTE 2: Test for water absorption shall be carried out as laid down in IS: 1124-1974, Method of test for determination of water absorption apparent specific gravity and porosity of natural building stones.

6.2.4 Dimensions of Stones :-Unless otherwise indicated, the length of stone for stone masonry shall not be exceed three times the height and the breadth on base shall not be greater than three fourth the thickness of wall. Height of stones may be up to 30 cm. Minimum dimensions of stones (except slate stone) for various type of masonry shall be as given below:

i) Stones for random rubble masonry may be of any size and shape but shall be not less than 15 cm in any direction.

ii) Stones for squared rubble masonry shall be not less than 15 cm in length and width.

iii) Stones for block-in-course masonry shall be not less than 20 cm in breadth or height and length than twice the height.

iv) Stones for ashlar masonry shall be not less than 30 cm in breadth and height and length not less than twice the height.

v) Stones for sills shall be of full thickness depth and width. Length of stone shall be as large as available but normally not less than 90 cm.

vi) Stones for lintels shall be of full thickness (depth) and length. Where stone lintel of full width is not available two stones may be used to make the width.

vii) Stones for copings shall be of full thickness and width. Length of stones shall be as large as available but not less than 30 cm.
tones for kerb stone shall be of size as indicated. The length shall not be not less than the height. (i) Stones for arches, domes and circular moulded work – the dimension shall depend on the particulars of the curve.

ix) In case of stone pitching the average dimension of boulders along the longest axis shall be approximately equal to the thickness of pitching.

Masonry mortars same as in the case of brick work shall be followed

6.7.1 Random Rubble Masonry

The stone shall be laid in their natural bed and shall be solidly laid in mortar.

a. Uncoursed: -This type of masonry shall be constructed of stones as they come from the quarry. The mason select stones of all shapes and sizes, more or less at random, and place them in position to obtain a good bond, while restricting cutting of the stones to the removal of inconvenient comers with a scrabbling or spalling hammer.

b. Brought to Course: -This walling is similar to uncoursed random rubble except that the work is roughly. Leveled up to course at intervals varying from 45 cm to 90 cm in height according to the locality and the type of the stone used.

68 General Requirements for Stone Masonry Construction:

6.8.1 All stone masonry shall be set out and built to the respective type; dimensions, thickness and height as indicated.

6.8.2 All labours on stone shall normally be executed when it is freshly quarried.

6.8.3 Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar.

6.8.4 The natural bed of the stratified stone shall be laid that the pressure is always perpendicular to the strata. Stone in walling, steps, copings, sills etc. shall be placed with the grain or natural bed horizontal. In arches the grain shall be parallel to bed or voussoirs. In projecting cornices and corbels the natural bed shall be vertical and at right angle to the face of the wall.

6.8.5 The courses shall be built perpendicular to the pressure, which the masonry will bear. In case of battered walls, the beds of stone and plane of courses shall be at right angle to the face of wall.

6.8.6. Vertical joints shall be staggered as fur as possible. In the case of squared rubble coursed masonry, block in courses masonry and Ashlar masonry, stone shall break joints on the face for at least half the height of the courses and the bond shall be carefully maintained through out.

6.8.7. Bell shaped bond stones or header shall not be used.

6.8.8 All necessary chases for joggles, dowels, and cramp shall be formed in the stone before hand.

6.8.9 Stone shall be laid on a full bed of mortar. All joints should be properly flushed and packed.

6.8.14 Protection: -Care shall be taken during construction that edges of jambs, sills, heads etc are not damaged. In inclement weather newly built work shall be suitably protect by covering with gunny bags of tarpaulin.

6.8.15 Curing: -Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days. Watering shall be done carefully so as not to disturb or wash out green mortar. In case of lime mortar, curing shall commence two days after the laying of masonry and shall continue for seven days.

6.8.16 Bond Stones: -Dressing of bond stone shall be done as for stones. In Coursed masonry full surface of the bed shall be dressed on the face, beds and joints and made into a squared block.

For pillars with a cross sectional area 0.25 sq m and below, the bond stone shall be a single full bond stone. For pillar exceeding 0.25 sq m either it shall be single bond stone or it shall be made up of four stones provided in two courses crossing the joints at right angle as directed by the EIC. The full bond stones shall be provided one at the bottom, one at the top and remaining in-between them at course not exceeding one
6.8.17 Plain Cement concrete Bond Stone:

Plain cement Concrete Bond stones of mix 1:3:6 Type C-1 may be provided in lieu of stone bond stones. The spacing of PCC bond stones shall be as specified for stone bond stone and shall be laid on the full section of the walling in one piece.

6.8.18 Construction Details:

Construction Details and respective specifications as given in brick work shall apply.

6.9 Stone Masonry Construction:

6.9.1 Random Rubble Masonry, Uncoursed.

6.9.1.1 Dressing: - Stone shall be hammered-dressed on the face, the sides and the beds to enable to come in proximity with the neighboring stones. The bushes on the face i.e. maximum depression from a straight edge held against the dressed surface shall not be more than 40 mm on an exposed face and 20 mm on faces to be rendered.

6.9.1.2 Laying: - Every stone shall be carefully fitted to the adjacent stone so as to form neat and close joint. Face stone shall extend and bond well in the back. These shall be arranged to break joints as much as possible and to avoid long vertical lines of joints. Thickness of joints shall not exceed 25 mm. Wall shall be leveled up at top of the plinths, sills and lintel level of openings, floor and roof levels and at top with minimum amount of chips and spalls.

The masonry shall be raised in plumb joints shall be either raked up a depth not less than 10mm and finished flush as directed.

6.9.1.3 Hearting Stones: - The hearting or interior filling of a wall face shall consists of rubble stone not less than 15 cm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting shall be laid nearly level with facing and backing.

6.9.1.4. Insertion of Chips: - Chips and spalls of stone shall be used wherever necessary to avoid thick mortar beds and joints and it shall be ensured that no hollow spaces are left anywhere in the masonry. Chips shall not be used below hearting stones to bring these up to the level of face stones. The use of chips and spalls shall be restricted to the filling of interstices between the adjacent stone in hearting and these shall not exceed 20 percent of the quality of a stone masonry. Spalls and pinning may show on faces.

Bond stones:

Through bond stones shall be provided in walls up to 60 cm thick. In the case of walls above 60 cm thickness, bond stones of the full thickness of wall or a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face to back. Bond stones shall not be less than 2 per sq m of face and staggered. No stone shall tail into a point. A distinguishing letter for subsequent verification shall marked on bond stones. Precast Cement Concrete (1:3:6) Type C-1 may be provided, cross section not less than 225 Sqcm and length equal to the thickness of wall at no extra cost.

6.6.1.6. Quoin & jamb Stones: - The quoin and jamb stones shall be selected stones, hammer dressed. Quoin stone shall not be less than 0.01 cu m in volume. Height of quoins and jamb stones shall not be less than 15 cm. Quoins shall be laid header stretcher alternately. Face bed and joints 5 cm and 2.5 cm respectively in case of granite or trap stone and 8 cm and 4 cm respectively in case of other stones, so that no portion of the dressed surface shall have a depression more than 6 mm from a straight edge held against the dressed surface.

6.7. Stone and Boulder Pitching

Stones shall be carefully hand packed in a manner to ensure a reasonably smooth surface and uniform thickness; spaces between the stones shall be minimized. Such spaces shall be wedged with spalls of suitable size, immediately following the packing of stones.
7.1 Ribs shall be provided at the junction of the slope with the ground and at the upper extremity of the slope. Ribs shall be rectangular in cross section with width equal to dimensions of stone along its longer axis and depth equal to depth of lining.

SECTION-7

WOOD WORK (CARPENTER’S WORK)

7.1 Indian Standards.- The following IS apply to this section:

<table>
<thead>
<tr>
<th>I. S. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>287-1973</td>
<td>Recommendation for maximum permissible moisture content of timber used for different purposes (third revision)</td>
</tr>
<tr>
<td>401-1982</td>
<td>Code of practice for preservation of timber (Second revision)</td>
</tr>
<tr>
<td>451-1972</td>
<td>Technical Supply conditions for wood screws (Second revision)</td>
</tr>
<tr>
<td>723-1972</td>
<td>Specification for steel countersunk head wire nails (First revision)</td>
</tr>
<tr>
<td>851-1978</td>
<td>Specification for synthetic resin adhesive for construction work (Non structural) in wood (first revision)</td>
</tr>
<tr>
<td>852-1969</td>
<td>Specification for animal glue for general wood work purposes (First revision)</td>
</tr>
<tr>
<td>4835-1979</td>
<td>Specification for polyvinyl acetate dispersion based adhesive for Wood (first revision)</td>
</tr>
</tbody>
</table>

MATERIALS

7.2 **DELETE**

7.3 Timber

Timber shall be of good quality, well seasoned, fairly uniform in colour and texture and free from blemishes, hollow pockets and loose knots, Coniferous sawn timber (soft wood) shall be free from spiral or twisted grain, warp, any kind of decay or live insect attack, and cup shakes. Non-coniferous sawn timber (hard wood) shall be free from bow, any kind of decay, live insect attack, spiral or twisted grains, splits, warp, cup and shake.

7.3.1 Timber shall be obtained either in cut size or as sleepers and cut to the required sizes well in advance of the commencement of fabrication and stacked at site of work in a suitable manner for seasoning.

7.4 Shoring and Strutting:-

Walls, floor roofs, partitions etc., where indicated or directed to be supported, shall be adequately shored to the satisfaction of the EIC. The contactor shall be responsible for the soundness and strength of the timber used for shoring and strutting and for properly bracing and securing them to sustain the pressure to which the shoring is likely to be subjected. Shoring shall be removed only after its removal has been approved by the EIC. Shoring shall consist of all requisite dogs, hoop iron, hooks, rakers sole-pieces, wall pieces, braces, trots, needles, cleats, wedges and posts. Shoring shall be of suitable structural timber, dean sawn. Raking shore may be at angle of 60° to 75° with a building but 40° is the best angle, if obtainable. Sole piece should be at right angle to the shore. The top needle should be at least 0.6 metre from the top of the wall.

7.5 Form Work (Centering and shuttering)

7.5.1 Materials :- Formwork shall be of timber. Alternatively the contactor may provide formwork of plywood timber with steel sheet lining or steel plate stiffened by steel angles without any price adjustment.

7.5.2 General requirement
st. It shall have sufficient strength and rigidity to withstand the load of concrete, vibrations, movement of men, materials and plants and any other incidental loads without excessive deflection beyond permissible limits. Before concreting is started, the props and wedges shall be thoroughly checked to see that these are intact, and are not loose. While concreting is in progress, a constant watch shall be kept on the props and immediate remedial measures taken as soon as any of these gets loosened. Care shall be taken that props and wedges do not get loose for the minimum period specified for the removal of formwork.

7.5.3 Propping and Centering.

The props shall consist of ballies, steel sections or of brick pillars laid dry or in mud mortar. Ballis shall be placed at a spacing of 1 to 1.2 meters and shall rest squarely on wooden sole plates. Double wedges shall be provided between the sole plate and the wooden prop, so as to facilitate tightening and easing of shuttering without jarring the concrete. In case brick masonry pillars are used as props, the wooden sole plate shall be provided at the top of pillar and double wedges inserted between the sole plate and the bottom of shuttering.

7.5.3.1 In case of multi-storeyed structures, the weight of concrete and formwork of any upper floor shall be suitably supported on at least two floors below the same.

7.5.3.2 In case the height of centering exceeds 3.50 metres, the props may be provided in Multi-stages.

7.5.4 Shuttering:

Shuttering for rough finish surface of concrete may have clean sawn or wrought surfaces which come in contact with concrete surface and planed on the sides. The shuttering for fair finish surface shall have wrought and smooth surfaces which come in contact with concrete surface and planed on sides. Joints shall not permit leakages of cement grout.

7.5.4.1 Form lining shall be such as would not discolour the concrete. Where steel sheet lining is provided to timber forms, it shall have, on mounting, minimum amount of kinks and other imperfections. Where metal forms are used, all bolts and nuts shall be countersunk and well ground to provide a smooth plain surface.

7.5.4.2 Where concrete is required to have a rounded edge, beveled edge or moulded edge, provision shall be made in the form itself. Opening for fan clamps and other fitting connected with services shall be provided in the shuttering as directed by the EIC.

7.5.4.3 As far as possible, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be easily withdrawn.

7.5.5 Surface Treatment to Shuttering

Forms shall be thoroughly cleaned of all dust, dirt, wood shavings and other matter by washing with water. The surface shall then be coated with soap solution before concreting is done. Soap solution shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively a coat of raw linseed oil/ refined pale paraffin mineral oil of approved manufacturer may be applied. Care shall be taken that the coating does not get on construction joint surface and reinforcement bars. It shall also not cause softening or permanent staining of concrete surface nor shall impede the wetting of surfaces to be water-cured. Special care shall be taken in case of small grooves. The form strips shall be oiled coated thoroughly so as to prevent swelling of the forms and consequent damages to the concrete on removal of forms.

7.5.6 Camber

The shuttering for beams and slabs shall have a camber of 1 in 250 and for cantilevers at the free end of 1/50 of the projected length or as directed by the EIC. '

7.5.7 Erection or Assembly of Forms

Formwork shall be erected true to line, vertical or battered to proper slope as required and
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex) -

VOLUME -II. TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

from twist. It shall be so assembled as to facilitate easing, and removal of the various parts in proper sequence without jarring the concrete. For columns etc., where concreting is done in stages, one side of the formwork shall be made in suitable parts and shall be capable of being fixed securely and quickly in position. The complete formwork shall be inspected and approved by the EIC before placing reinforcement and laying concrete.

The formwork shall confirm to the shapes, lines and dimensions as shown on the drawings or as indicated, within the tolerance given below:-

(a) Deviation from specified dimension of cross section of column and beam.  
-6mm  +12mm  (See Note)

(b) Deviation from dimension of footing  
(i) Dimension in plan  -12mm  +30mm  
(ii) Eccentricity  0.02 times the width of footing in the direction of deviation but not more than 50 mm.

Note:- Tolerance apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowel

7.5.8 Striking/Removal of Forms

Forms shall be removed gently. They shall be eased carefully in order to prevent the load being suddenly transferred to concrete. The minimum period that shall elapse after the concrete has been laid and before form work is eased and removed is given in section-4: Concrete, for ordinary Portland cement.

Notes :
1: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. If Portland pozzolana or low heat cement has been used for concrete, the stripping period will be increased suitably as indicated or directed by EIC.
2: The number of props left under, their sizes and disposition shall be such as to be able to Safely carry the full dead load of the slabs, beams or arch as the case may be, together with any live load likely to occur during curing or further construction.
3: For rapid hardening cement periods will be suitably decreased as indicated or directed by EIC. However for vertical side of slabs, beams and columns forms should be retained for at least 24 hrs
4: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.
5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.
6: Work damaged through or careless removal of forms shall be reconstructed.

7.5.9 Reuse .

Before reuse, the forms shall be thoroughly scraped, cleaned and joints gone over and repaired where necessary. Inside surface shall be retreated to prevent adhesion of concrete.

7.5.10 Inspection of Form Work .

The completed form work shall be inspected and approved by the EIC before the reinforcement bars are placed in position.

Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discoloration of concrete etc. Proper and accurate alignment and profile of finished concrete surface shall be ensured by proper designing and erection of form work which will be approved by EIC.

Shuttering surface before concreting should be clean and all defects and dust removed. The shuttering should be in perfect condition. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
5.11 Erection of Form Work (centering and shuttering)

Following points shall be borne in mind while checking during erection:
(a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.
(b) Material used should be checked to ensure that, wrong items/rejects are not used. If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
(c) (i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
(ii) Soleplates shall be properly seated on their bearing pads or sleepers.
(iii) The bearing plates of steel props shall not be distorted.
(iv) The steel parts on the bearing members shall have adequate bearing areas.
(d) Safety measures to prevent impact of traffic scour due to water etc., should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.
(e) Bracing, struts and ties shall be installed along with progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (specially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.
(f) The stacked materials shall be placed as catered for, in the design.
(g) When adjustable steel props are used, they should
(i) be undamaged and not visibly bent,
(ii) have the steel pins provided by the manufacturers for use,
(iii) be restrained laterally near each end,
(iv) have means for centralizing beams placed in the foreheads,
(h) Screw adjustment of adjustable props shall not be over extended.
(i) Double Wedges shall be provided for adjustment of the form to the required position wherever any settlement/elastic shortening of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/clamped down after adjustment to prevent their shifting,
(m) No member shall be eccentric upon vertical member.
(k) The number of nuts and bolts shall be adequate.
(l) All provisions of the design and/or drawings shall be complied with.
(m) Cantilever supports shall be adequate.
(n) Props shall be directly under one another in multistage constructions as far as possible.
(o) Guy ropes or stays shall be tensioned properly.
(p) There shall be adequate provision for the movement and operation of vibrations and other construction plant and equipment.
(q) Required camber shall be provided over long spans.
(r) Supports shall be adequate, and in plumb within the specified tolerance.

SECTION-8

JOINERY

8.1 Indian Standards

The following IS apply to this section:

<table>
<thead>
<tr>
<th>IS No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>303-1975</td>
<td>Specification for plywood for general purposes (second revision) with Amdt No.1 to 3.</td>
</tr>
<tr>
<td>1328-1982</td>
<td>Specification for veneered decorative plywood (second revision)</td>
</tr>
<tr>
<td>1659-1979</td>
<td>Specification for block boards (first revision)</td>
</tr>
<tr>
<td>2202 (part I)-1983</td>
<td>Specification for wooden flush door shutters (solid core type), part I, plywood face panels (fourth revision)</td>
</tr>
</tbody>
</table>
MATERIALS

8.2 Plywood

Plywood used for paneling of door shutters shall be B WR grade conforming to IS 303-1975. Specification for plywood for general purposes. Decorative plywood panels where indicated, shall conform to IS 1328, specification for veneered decorative plywood.

8.3 Block Board

Block boards used for paneling of doors shutters shall be grade I, exterior grade commercial type and conform to. IS 3087 and shall have been bonded with BWR type of synthetic resin adhesive.

8.4 Veneered Particle Board: Veneered particle board used for panels shall be bonded with BWR type synthetic resin adhesive and shall conform to exterior grade of IS 3097, specification for veneered particle boards. Where indicated veneered particle boards shall be decorative type. Particle board used for core of veneered particle board shall be type Ex. SO GP or SOD conforming to IS 3087 and shall have been bonded with BWR type of synthetic resin adhesive.

WORKMANSHIP

8.5 Joiner's Work Generally

8.5.1 Species of Timber: Only the species of timber indicated shall be used.

8.5.2 All exposed surfaces of joinery shall be planed smooth (wrought) and neatly and truly finished to the full dimensions, rebates, rounding and mouldings as indicated. Unless dimensions are indicated to be finished dimensions, a tolerance of 1 mm shall be permitted for each wrought face

8.5.3 Jointing: The contractor shall observe the following principles in forming joints:

(a) To cut the joints and arrange the fastenings in such a way so as to weaken as little as possible the pieces of timber they connect.

(b) To place each abutting surface in a joint, as nearly as possible, perpendicular to the pressure it has to transmit.

(c) To form and fit accurately every pair of surfaces that come in contact.

8.5.4 Joints shall be made carefully and accurately. All mortice and tenon and other joints shall fit fully and truly with out wedging or filling and finished neatly. Where indicated, butt joints shall be cross tongued. The tongue shall be cut at right angles or diagonally to the grains of the wood.

8.5.5 Defective knots, when permitted on surfaces exposed to view, shall be completely bored or cut out and tightly plugged with the same timber species and properly glued in. The grains of plug shall run in the direction of the grains of piece.

8.5.6 Framing shall be done in the best possible manner. Members shall be fabricated neatly and accurately so that these can be assembled without being unduly packed. Strained or forced into position and when built up shall be true to shape and free from twist or open joints. Framed joints shall be glued together and pinned with bamboo or hard wood pins.

8.5.7 All joiner's work shall be cut and framed together well ahead of their incorporation in the work but shall not be edged up until required for fixing in position and passed by the EIC. Any portion that may warp or develop shakes or other defects shall be replaced with new before being wedge up.
8.5.8. The contact surfaces of mortice and tenon shall be glued before putting together with bulk type synthetic resin adhesive to IS 851-1978 suitable for construction work in wood. Tongued and grooved joints shall also be properly glued together with a suitable adhesive.

8.6 Nailing, Screwing etc.

Nailing, screwing etc., of the various members of joinery, where necessary shall be done as directed by the EIC. When driving the screws, it is advisable that in case of hard timbers pilot holes are drilled before fixing the screw. The screws shall be driven tight fit and straight.

8.6.1 Clearing:

After the plaster and grouting have dried, all splatter and marks of cement shall be removed and the frames cleaned.

8.6.2 In the case of frames without sill the vertical members shall be buried in the floor for the full thickness of the floor finish.

8.6.3 The holdfasts shall be tightly fixed to the frame by means of bolts or wood screws as indicated, the bolt hole in the frame being plugged suitably and finished neat unless otherwise indicated.

8.7 Shutters Generally

8.7.1 The types of shutters for doors, windows, ventilators, cupboards, etc., viz. panelled, glazed, wire gauzed, partly paneled and partly glazed or gauged, ledged braced and batten, louvered etc., shall be as indicated, and detailed in the drawings.

8.7.2 All members of "the shutter shall be made out of one piece and shall be straight without any wrap or bow. They shall have smooth, well planned surfaces at right angles to each other. The right angles of the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one.

8.7.3 The contact surfaces of mortice and tenon and tongued and grooved joints shall be glued before putting together.

8.7.4 In the case of double leaved shutters the meeting 'stiles shall be rebated 20 mm or as shown on drawings. The rebating shall be splayed or square, as directed.

8.7.5 All shutters shall be finished smooth with well planned faces.

8.7.6 Tolerance in the thickness of joinery shall be ±2 mm.

8.7.7 Shutters shall be of correct size and shall, fit into the frames without excessive cutting at the edges. Adding of wooden strips etc., to make up the size shall not be allowed.

8.7.8 Factory made shutters:

Where indicated the contractors shall supply flush, paneled glazed and gauzed door and window shutters made in an approved factory. Tolerance on the width and height of factory made shutters shall be +/- 3mm provided the shutter snugly fits into the frame, glass in case of glazed shutters and of wire cloth in case of gauzed shutters.

8.8 Flush Door Shutters:

8.8.1 Flush door shutters shall be factory made solid core types with block board core, and shall conform to IS 2202 (part 1)-1 999. Specification for wooden flush door shutters (solid core type) Part I plywood face panels; except with regard to the sizes' of shutters which shall be as indicated. Flush door shutters shall be non-decorative (commercial) type or decorative type where indicated.

8.8.2 Flush door shutters shall be internally lipped. Internal lipping may be provided separately or as one piece with the frame. The width of frame including lipping shall not be less than 50 mm. Internal lipping shall have a total depth of not less than 25 mm. Joints shall not be permitted in lipping.
8.8.3 In the case of double leaved shutters, rebating shall be splayed or square as directed. Where separate lipping is indicated, the depth of lipping at the meeting of the stiles shall not be less than 35 mm.

8.8.4 Flush door shall be free from twist or wrap in plane ‘and all the four edges of the door shutter shall be square. Both the faces of the door shutter shall be sanded to a smooth even texture.

8.8.5 Tolerance on nominal thickness shall be +/-1.2 mm. Thickness of shutter shall be uniform through out with the variation not exceeding +/-0.8 mm when measured at any two points.

8.8.6 Opening for Glazing:

Where indicated, opening for glazing with minimum size of 25x20 cm shall be provided, which shall be lipped internally with solid timber.

8.8.7 Locks:-

Shutters shall be shop prepared for taking mortice locks and latches.

8.8.8 Flush door shutters fixed in bathrooms and toilets shall be protected by providing aluminium sheet cover 0.5 mm thick where indicated. Aluminium sheets shall conform to IS 737-1986. Aluminium sheet shall be fixed to the door with chromium plated steel round headed screws conforming to IS 1284-1974 at a distance not exceeding 10 cm centre to center.

8.9 Fixing of Shutters

8.9.1 The size of the openings and the frames shall be checked and also the verticality of the side frames and the level position of the floor and the wall. Any adjustment necessary shall be made before installation of the shutters. The shutters shall be installed only after the walls on either side have dried.

8.9.2 Any transit defects or storage defects in shutters shall be filled up with a. good putty. Any corner opening may be rectified by the use of glued and pressing by 'c' clamps. Any damage to moulding or glazing bars or other fixtures shall be rectified at site by use of similar materials.

8.9.3 Width of hinges shall suit the shutter thickness.

8.9.4 Cleats, where indicated, shall properly fit in the rebates of the chowkats to effectively stop the shutter from closing.

8.9.5 When driving screws it is advisable that in case of hard timbers pilot holes are drilled before fixing the screws. The screws shall be driven tight fit and straight.

8.9.6 Shutters shall be checked after fixing for proper location alignment and swinging. After all the fixtures have been fitted, the shutters shall be tried again for proper closure, handling and movement. Any rectification necessary shall be done.

8.9.7 Fixed Shutters:

Shutters fixed in the frames shall be secured to the frames with wood screws of adequate size at intervals of not more than 40 cm, unless otherwise indicated.

8.10 Fire Doors (120 Minutes)

Material

Door Frames and Shutter are made from G.I Sheets and should confirm to IS - 3614(Part 2)1992 BS 476 (Part 20 and 22) and ISO 834and all testing procedures shall be followed as per the given code.

Door Shutter

Door shutters should be constructed from 1.20mm thick G.I. sheet formed to provide a 46mm thick fully flush, double skin door shell with lock seam joints at stile edges. Internal Reinforcements are provided at top, Bottom and Stile Edges for Fire Rating. The inner core is a light weight Honey Comb Raisned Board
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex) VOLUME –II TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

containing no asbestos or other inorganic fibers. The internal construction of the doors varies with the degree of Fire Rating as tested.

**Door Frames**

Produced from 1.6mm thick galvanized steel sheet formed to single/double rebate profile of size 143mm x 57mm (+/- 0.3mm) with a maximum bending radius of 1.4mm.

The door frames may be built into the brick or block walls using corrugated “TEE” Anchors not welded to the frame (first fix). Frames may also be fixed on plastered openings with the help of Metallic Expansion Shield with counter sunk screw (second fix). Doors Frames are supplied to knock-down form with butt joints for bolted assembly at site.

**Finish**

The door frames and door shutters are primed with epoxy based Primer and finished with polyurethane aliphatic grade, UV resistant oven dried paint as required up to a minimum of 70 microns.

**8.11 Acoustic Doors**

**Material**

Door Frames and Shutter are made from G.I Sheets and should confirm to IS: 3614 (Part) 1992 and all testing procedures shall be followed as per the given code. Acoustic doors shall have an STC Rating of 36Db or as per manufacturers specification for rigidity and sound insulations and ARAI (Pune) Tested.

**DOOR AND FRAME FEATURES:**

**Testing:** Stop Noise Door products are tested in accordance with the most recent ASTM E90 standards at accredited Acoustical Laboratories.

**Services:** Contractor shall provide the necessary shop drawings for approval of the Consultant and Engineer – in – Charge.

**IRONMONGERY**

**HINGES**

SS Ball bearing butt Hinges 4mm thick and 150x102mm (3 numbers or More), fixed flushed to the frame and shutter.

**LOCK**

Mortise Sash Lock with Lever Handles, Mortise Dead Bolt, Mortise Latch, Panic Devices etc

**FLUSH BOLTS (DOUBLE DOOR)**

Concealed extended lever action flush bolts provided on the top of the door to the leading stile edge.

**DOOR CLOSERS**

Suitable Door Closers shall be provided as directed by the Consultant / EIC..

**ADDITIONAL ACCESORIES**

Electro Magnetic Hold Open Device, Smoke Seals for Air tightness, Automatic Door Bottoms etc., can be provided if required.

**Mode of measurements :**

The door shall be measured including the frame outer to outer. The square meter areas for shutters shall be measured outside to outside for the exposed surfaces of shutter including the frame. The linear dimensions shall be measured up to two places of decimals of a meter. The area for payment shall be worked out up to two places of decimals of a square meter. The rate for shutters shall include:

- Cost of supply assembly and erecting in position.

**SIGNATURE OF TENDERER WITH SEAL**
Cost of labour for making adjustments in frames, if required, shutters and also for fixing required fittings and fixtures mentioned in above paragraph.

the rate for individual item mentioned in the schedule of quantities shall include cost of shutters, labour for provision of glass for vision panel, hardware fittings mentioned in the ironmongery heading, transporting charges and labour for fixing of fixtures and fastening fixing of door closers and painting and polishing to match the wall panel surface as specified.

SECTION -9

BUILDER’S HARDWARE

9.1 Indian Standard

The following IS apply to this section with latest revision:

<table>
<thead>
<tr>
<th>I.S.No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>204 (part I) 1978</td>
<td>Specification for tower bolts, Part I, Ferrous tower bolts (fourth revision)</td>
</tr>
<tr>
<td>204 (part-II) 1978</td>
<td>Specification for tower bolts, Part II, Non Ferrous tower bolts (fourth revision with Amdt. No.1)</td>
</tr>
<tr>
<td>205-1978</td>
<td>Specification for Non ferrous metal butt binges (third revision)</td>
</tr>
<tr>
<td>206-1981</td>
<td>Specification for tee and strap hinges (third revision with Amdt. No.1)</td>
</tr>
<tr>
<td>207-1964</td>
<td>Specification for gate and shutter hooks and eyes (revised)</td>
</tr>
<tr>
<td>208-1979</td>
<td>Specification for door handles (third revision)</td>
</tr>
<tr>
<td>281-1973</td>
<td>Specification for mild steel sliding door bolts for use with pad-locks (second revision)</td>
</tr>
<tr>
<td>362-1982</td>
<td>Specification for parliament hinges (fourth revision)</td>
</tr>
<tr>
<td>363-1976</td>
<td>Specification for hasps and staples (third revision)</td>
</tr>
<tr>
<td>364-1970</td>
<td>Specification for fanlight catch (second revision)</td>
</tr>
<tr>
<td>452-1973</td>
<td>Specification for door springs, rat-tail, type (second revision)</td>
</tr>
<tr>
<td>453-1973</td>
<td>Specification for double acting spring hinges (second revision)</td>
</tr>
<tr>
<td>729-1979</td>
<td>Specification for drawer locks, cup board locks and box locks (third revision)</td>
</tr>
<tr>
<td>10 19-1974</td>
<td>Specification for rim latches (second revision with Amdt. No.1)</td>
</tr>
<tr>
<td>1341-1981</td>
<td>Specification for steel butt hinges (fourth revision with Amdt. No.1 &amp; 3)</td>
</tr>
<tr>
<td>1568-1970</td>
<td>Specification for wire cloth for general purposes (first revision with Amdt. No.1)</td>
</tr>
<tr>
<td>1823-1980</td>
<td>Specification for floor door stoppers (third revision)</td>
</tr>
<tr>
<td>1837-1966</td>
<td>Specification for fan. light pivots (first revision with Amdt. No.1)</td>
</tr>
<tr>
<td>2209- 1976</td>
<td>Specification for mortice lock (vertical type) (third revision with Amdt. No 1 &amp; 2)</td>
</tr>
<tr>
<td>2681-1979</td>
<td>Specification for non-ferrous metal sliding door bolts (Alldrops) for use with padlocks (second revision with Amdt.No 1 &amp; 2)</td>
</tr>
<tr>
<td>Specification</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>3564-1986</td>
<td>Specification for door closers (hydraulically regulated) (third revision with Amdt.No.1)</td>
</tr>
<tr>
<td>3818-1986</td>
<td>Specification for continuous (Piano) hinges (second revision with Amdt. No1)</td>
</tr>
<tr>
<td>3847-1966</td>
<td>Specification for mortice night latches (with Arndt No 1&amp;2)</td>
</tr>
<tr>
<td>5187-1972</td>
<td>Specification for flush bolts (first revision with Amdt. No 1)</td>
</tr>
<tr>
<td>5930-1970</td>
<td>Specification for mortice latch (vertical type with Amdt. No1)</td>
</tr>
<tr>
<td>6607-1972</td>
<td>Specification for rebated mortice locks (vertical type with Amdt No 1)</td>
</tr>
<tr>
<td>7534 -1985</td>
<td>Specification for mild steel locking bolts with holes for pad lock (first revision)</td>
</tr>
</tbody>
</table>

**MATERIALS**

9.2 Builder's Hardware Generally

9.2.1 Materials:

Articles of builder's hardware (fittings) shall be of mild steel, cast iron, brass, aluminium alloy etc., as indicated. The type and size of fittings shall also be indicated. Fittings shall be of approved make.

9.2.2 Shape and dimensions:

The shape and dimensions of the fittings shall conform to the shape and dimensions given in the relevant IS specifications, unless otherwise indicated. Where however, shape of fittings or its components are indicated in the relevant IS Specification, as illustrative, they are not intended to limit their design. Such fittings or components shall be provided of the shape as approved by the consultant and EIC. '

9.2.3 Where no IS Specification are indicated, such fitting shall be provide as approved and directed by the consultant and EIC.

9.2.4 Finish:

Except where otherwise specified, articles of builder's hardware shall have the following finish:-

| (a) Mild steel and cast iron fittings | : | Stove enabled black |
| (b) Brass fittings | : | Finished bright or satin finish |
| (c) Aluminium fittings | : | Powder coated. |

9.2.5 Manufacture:

Fittings shall be well made and finished to the correct shape and size, free from surface defects and flaws and shall have smooth action. Cast fittings or components' shall be free from casting and other defects. All burrs, sharp edges and corners shall be removed and finished smooth.

9.2.6 Screws:

Unless otherwise indicated, brass articles shall be fixed with brass or stainless steel screws and mild steel, cast iron and aluminium articles with steel chromium plated screws or as indicated. Screws shall be of sizes as indicated in the I.S specification for the fittings or as required.

9.2.7 Tower Bolts

9.3.1. Generally:-

Steel tower bolts shall comply with IS 204(part-I)-1978, specification for tower bolts, part-I, ferrous metals,
9.3.1.1 Barrel and skeleton tower bolts, wherever possible, shall have the knob integral with bolts. In case it is not possible to provide a single piece construction of bolts, the knob may preferably be fitted to the bolts with a pin or alternatively screwed and riveted to the bolts, and its shape may be round, half round spherical or conical as indicated and of robust construction.

9.3.1.2 Where diameter of bolts of particular size of tower bolt is stated in the IS as 10 or 12 mm, the bolt shall be of 10 mm dia upto size 125 mm and 12 mm dia for sizes 150 mm and above.

9.3.1.3 All M.S tower bolts made with steel 1.2 mm thick M.S sheet and above shall have countersunk screw holes.

9.3.1.4 Non-Ferrous Tower Bolts:

Brass and aluminium tower bolts shall be of types as given above. These shall be provided with a small spring and ball on the inside of the barrel for smooth working. Brass bolts and barrels shall be polished bright. Aluminium alloy bolts and barrels shall be powder coated, size of bolt shall be as indicated. Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy.

9.4 Flush Bolts.

Flush bolts shall comply with IS 5187 specification for flush bolts. These shall be of type –2 and of the following material and finish, as indicated: -

(a) Brass flush bolt with cast brass body and plate and cast brass or extruded brass bolt, and steel strip spring.
(b) Aluminium flush bolt with cast aluminium alloy or extruded aluminium alloy body and plate and extruded aluminium alloy bolt and steel strip spring.

9.3.1 Brass flush bolts shall be bright finished. Aluminium flush bolts shall be powder coated.

9.5 Sliding Door Bolts

9.5.1 Mild Steel Sliding Door Bolts:

These shall be bolt type and comply with the requirement of IS 281. Hasp, clips, and staple plate shall be made from mild steel sheets. Sliding bolts shall be made from round mild steel bar.

HASP, bolt, staple and clips or fixing bolts shall be copper oxidised in accordance with IS 1378 or plated with nickel or chromiun in accordance with IS 1068 as indicated.

9.5.2 Non-Ferrous Metal Sliding Door Bolts:

These shall comply with IS 2681, specification for non-ferrous sliding door bolts for use with padlock.

9.5.2.1 The sliding door bolt shall have a smooth sliding action. The hasp, when not cast integral with the bolt, shall be properly secured to the bolt. Sliding bolts shall be provided with fixing bolts. Brass bolts shall have satin finish or polished. Aluminium bolts shall be powder coated.

9.6 Steel Locking Bolts

These shall comply with IS 7534, specification for mild steel locking bolts with holes for padlocks. Locking bolt shall have smooth sliding action. Bolt shall be made from mild steel and polished bright. The plate and strap shall be firmly riveted or spot welded and shall be stove enameled black. Locking bolt shall be Type II size of bolt shall be indicated.

9.7 Hinges

9.7.1 Generally:

Hinges shall be well made and shall be free from flaws and defects. All hinges shall be cut clean and square. The hole for the hinge pin shall be central and square to the, knuckles/ boss. All sharp edges and
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex)
VOLUME -II. TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

9.7.2 Steel butt hinges shall be of cold rolled mild steel and shall comply with IS 1341 specification for steel butt hinges. Steel butt hinges are classified as lightweight, medium weight and heavy weight. Hinges shall be of heavy weight, unless otherwise indicated. The pins shall be of mild steel/stainless steel. Hinges shall be finished bright with smooth surface.

9.7.3 Non-Ferrous Metal Butt Hinges:
Brass and Aluminium butt hinges shall comply with IS 205 specification for non-ferrous metal butt hinges and shall be of cast brass, extruded brass or extruded aluminium alloy, as indicated. Brass hinges shall be polished bright or stain finished. Aluminium hinges shall be powder coated.

9.7.3.1 In case of brass hinges, the hinge pin shall comply with IS 205. In case of aluminium alloy hinges, the hinge pin shall be of mild steel/stainless steel, galvanized, where indicated.

9.7.3.2 Non ferrous metal butt hinges shall be of the size as indicated

9.7.4 Mild Steel Tee Hinges:
M.S.Tee hinges shall comply with IS 206. Specification for tee and strap hinges' and shall be of medium type; or of heavy type where indicated. Tee hinges shall be finished stove enameled black.

9.7.5 Parliament Hinges:
Parliament hinges shall comply with IS 362 specification for the parliament hinges. Requirement of the hinge pin and finish of the hinges, shall be as described for butt hinges.

9.7.6 Continuous (piano) Hinges:
Continuous (piano) hinges shall be as per IS 3818 Type II specification for continuous (piano) hinges. These shall be of mild steel galvanized or aluminium alloy as indicated. In the case of aluminium hinges, the hinge pin shall be of aluminium and in the case of steel hinges, the hinge pin shall of mild steel Mild steel hinges shall be bright polished chromium plated. Aluminium hinges shall be anodized.

9.7.7 Double Acting Spring Hinges:
Double acting spring hinges shall comply IS 453. Specification for double acting spring hinges. MS hinges shall be finished store enameled black.

9.7.8 Door Springs Rat-Tail Type:
These shall conform to IS 452-1973 specification for door springs, rat-tail type and shall be of mild steel or brass as indicated. In case of mild steel door springs, casing, tail rod, spindle cap and base plate shall be stove enamelled, black, spindle, roller plate and roller shall be bright finished. Brass door spring shall be bright finished. Spring for both mild steel and brass door spring shall be of mild steel wire, copper oxidized or electro galvanized as indicated.

9.8 Latches
Latches shall be supplied left handed or right handed depending on the type of door to which they are fitted and as directed.

9.8.1 Rim Latches:
These shall comply with Type I of IS 1019. Specification for rim latches. They shall be of mild steel brass or aluminium alloy as indicated. Locking pin shall be provided to facilitate locking from one side. In case of mild steel rim latches, the body, striking box, spindle and back plat shall be of mild steel; the latch bolt, follower, locking pin, knobs, and disc shall be of brass. In the case of brass and aluminium alloy latches, body striking box and back end plate and disc shall be of brass and aluminium alloy respectively. All other components shall be of brass. Spring for mild steel, brass and aluminium rim latches shall be of steel wire.
Spring type lever handles may be provided in lieu of knobs where indicated. When the knob / lever handle of the latch bolt shall draw smoothly into the body.

Mild Steel rim latches shall be finished stove enameled black. Brass latches shall have bright or satin finish. Aluminium latches shall be powder coated.

9.8.2 Mortice Night Latch:

Mortice night latch shall conform to IS 3847. Specification for mortice night latches. These shall be of mild steel brass or aluminium alloy as indicated.

Various components and finish shall be as described for mortice locks (vertical type) Face plate shall be provided in front of case plate.

9.8.3 Mortice Latch (Vertical Type):

Mortice latch (vertical type) shall conform IS 5930. Specification for mortice latch (vertical type). These latches shall be capable of being operated both from inside and outside and shall be provided with a thumb turn knob fitted on the handle plate in order to close the door from inside. The latches will be of mild steel or brass or aluminium alloy as indicated. Various components and finish shall be as described for mortice locks (vertical type). Face plate shall be provided in front of the case plate, size of latch shall be indicated.

9.9 Locks

9.9.1 Generally:

Number of levers shall be as indicated. The locks shall be supplied with two keys. Where more than one lock is provided no key of the lock shall fit any other lock supplied. All components of the locks and keys shall be finished smooth to minimize frictional resistance in the working. The size of lock shall be indicated.

9.9.2 Mortice locks (Vertical Type):

These shall conform IS 2209. Specification for mortice lock (vertical type). These shall be of mild steel, brass or aluminium as indicated. No. of levers shall also be as indicated.

9.9.2.1 The lock shall be made easy working with lever and shall be capable of being opened with the key from both inside and outside. Face plates shall be provided in all locks. Mild steel body shall be given a protective coating such as painting. Brass body shall be finished bright. Aluminium alloy body shall be powder coated. Face plate and striking plate shall be finished smooth, and finished bright for brass and mild steel locks; and powder coated for aluminium locks.

9.9.3 Rebated Mortice Locks:

These shall conform to IS 6607. Specification for rebated mortice locks (vertical type). These shall be of mild steel, brass or aluminium as indicated. Material for various components of rebated mortice locks and their finish shall be as described for mortice locks (vertical type).

9.10 Hasps and Staples

These shall conform to IS 363. Specification for hasp and staples. These shall be of the following types as indicated:-

Mild steel hasp and staple-wire type.
Mild steel hasp and staple-safety type.
Brass hasp and staple-safety type.
Aluminium alloy hasp and staple-safety type.

9.10.1 Hasps and staples shall be well made and free from defects. The hinge pin shall be of mild steel in the case of hasp and staples. The hasps shall fit the staples correctly. The staple, except in the case of cast one, shall be riveted properly to its plate. The hinge pin for the safety type hasp shall be riveted and rivet head properly formed and finished. Screw holes shall be clean and counter sunk to suit counter sunk head wood screws.

9.11 Handles

Mild steel hasps and staples shall be stove enameled black. Brass hasps and staples shall be finished bright and covered with clear lacquer. Aluminium alloy hasps and staples shall be powder coated.
These shall conform to IS 208. Specification for door handles.

9.11.1 Door handles shall be finished smooth. When the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembly handle shall have adequate strength. Cast iron, malleable cast iron and mild steel door handles shall be finished stove enamelled black. Brass handles shall be with bright polished finish. Aluminium handles shall be powder coated.

9.12 Floor Door Stoppers

These shall conform to IS 1823. Specification for floor door stoppers.

9.12.1 The door stopper shall be well made and shall have smooth action. The body or housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or aluminium screws. The spring shall be fixed firmly to the pin. The tongue, which would be pressed while closing or opening of the door, shall be connected to the lower part by means of copper pin. On the extreme end, a rubber piece shall be attached to absorb shocks due to the pulling action of the door.

9.12.1.1 The exterior of the brass door stopper, which will be in flush and above the floor, shall be finished bright or satin and exterior of aluminium stopper shall be powder coated.

9.13 Door Closers (Hydraulically Regulated)

These shall comply with IS 3564, specification for door closer and shall be of designation as indicated. Door closers shall have aluminium alloy body, as indicated. Closers shall be universal type suitable for both anticlockwise and clockwise without any change in parts of the closers.

Door closers with aluminium body shall be as per IS.

The surface of the closer shall be clean; without sharp edges, free from cracks, burrs, dents or any other visible surface defects. The door closer shall not allow any sign of leakage under working conditions. The closing time shall be easily adjustable by means of regulating screw.

WORKMANSHIP

9.15 Generally

All builder’s hardware shall be fixed to joinery in a secure and efficient manner. Special attention shall be given to the size and fixing of screws to ensure that the screws are driven (and not hammered) tight and the heads of the screw do not protrude.

9.16 Hinges

All hinges except T or strap hinges shall be countersunk into the edge of timber joinery and frames to a depth equal to the thickness of the leaf of the hinge.

9.17 Fanlight, etc.

When fanlights or windows are center hung, fanlight pivots shall be fixed slightly off the center so that the fanlights and windows may normally remain in the open position.

9.18 Metal Sockets

These shall be provided to all tower bolts and sliding bolts where the bolts enter brick, stone, or concrete. These shall be securely fixed flush with the surface into mortices and cemented. Mortice plates over holes shall be provided where the soots enter wood.

9.19 Oiling

All locks, bolts, springs, and other items of builder’s hardware with moving parts shall be properly oiled and handed over in working condition on completion.

SECTION-10

STEEL, IRON AND ALUMINIUM WORK

10.1 Indian Standards The following IS with latest revision apply to this section:
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>210</td>
<td>Specification for Grey Iron casting (Fourth revision)</td>
</tr>
<tr>
<td>277</td>
<td>Specification for Galvanised Steel sheet (plain and corrugated) (Sixth revision)</td>
</tr>
<tr>
<td>278</td>
<td>Specification for Galvanised Steel Barbed wire for fencing (Third revision)</td>
</tr>
<tr>
<td>280</td>
<td>Specification for mild steel wire for general engineering purposes (Fourth revision)</td>
</tr>
<tr>
<td>412</td>
<td>Specification for expanded metal steel sheet for general purposes (Second revision)</td>
</tr>
<tr>
<td>432</td>
<td>Specification for mild steel and medium tensile steel wire for concrete reinforcement, Part I, Mild steel and medium tensile steel bars (Third revision)</td>
</tr>
<tr>
<td>432</td>
<td>Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement, Part II, Hard drawn steel wire (Third revision)</td>
</tr>
<tr>
<td>733</td>
<td>Specification for wrought aluminium and aluminium alloys bars, rods and sections (for general engineering purposes). (Third revision)</td>
</tr>
<tr>
<td>737</td>
<td>Specification for wrought aluminium and aluminium alloys sheet and strip for general engineering purposes (Third revision)</td>
</tr>
<tr>
<td>800</td>
<td>Code of practice for general construction in steel (Second revision)</td>
</tr>
<tr>
<td>806</td>
<td>Code of Practise for use of steel tubes in general building construction</td>
</tr>
<tr>
<td>808</td>
<td>Dimensions for hot rolled steel beam, column, channel and angle sections. (Third revision)</td>
</tr>
<tr>
<td>811</td>
<td>Cold formed light gauge structural steel section. (Revised)</td>
</tr>
<tr>
<td>814</td>
<td>Specification for covered electrodes for manual metal arc welding of carbon and carbon managese steel (sixth revision)</td>
</tr>
<tr>
<td>816</td>
<td>Code of practice for use in metal arc welding for general construction in mild steel (First revision)</td>
</tr>
<tr>
<td>818</td>
<td>Code of practice for safety and health requirement in electric and gas welding and cutting operations (First revision)</td>
</tr>
<tr>
<td>822</td>
<td>Code of procedure for inspection of welds.</td>
</tr>
<tr>
<td>1038</td>
<td>Specification for steel doors, windows and ventilators (Third revision)</td>
</tr>
<tr>
<td>1081</td>
<td>Code of practice for fixing and glazing of metals (steel and aluminium) doors, windows and ventilators.</td>
</tr>
<tr>
<td>1148</td>
<td>Specification for hot rolled rivet bars (up to 40mm diameter) for structural purposes (Third revision).</td>
</tr>
<tr>
<td>1173</td>
<td>Hot rolled slit steel tee bars (Second revision)</td>
</tr>
<tr>
<td>1252</td>
<td>Dimension of Hot rolled steel bulb angles (First revision)</td>
</tr>
<tr>
<td>1285</td>
<td>Specification for wrought aluminium and aluminium alloys extruded round tube and hollow sections for general engineering purposes (Third revision)</td>
</tr>
<tr>
<td>1361</td>
<td>Specification for steel windows for industrial buildings (First revision)</td>
</tr>
<tr>
<td>1363</td>
<td>Hexagon head bolts, screw and nuts of product grade 'C' - Part-I, Hexagon head bolts (Part 1) (Size range M5 to M64) (Fourth revision)</td>
</tr>
<tr>
<td>1363</td>
<td>Hexagon head bolts, screw and nuts of product grade 'C' - Part-II, Hexagon (Part 2) head screws (Size range M5 to M64) (Fourth revision)</td>
</tr>
<tr>
<td>1363</td>
<td>Hexagon head bolts, screw and mts of product grade 'C' - Part-III, Hexagon (Part 3) nuts (Size range M5 to M64) (Third revision)</td>
</tr>
<tr>
<td>1367</td>
<td>Technical supply conditions for threaded fasteners</td>
</tr>
<tr>
<td>1566</td>
<td>Specification for hard drawn steel wire fabric for concrete reinforcement (Second revision)</td>
</tr>
<tr>
<td>1730</td>
<td>Dimensions for steel plates, sheets, strips and flats for general engineering purposes (Second revision)</td>
</tr>
<tr>
<td>1732</td>
<td>Dimensions for round and square steel bars for structural and general engineering purposes, (Second revision)</td>
</tr>
<tr>
<td>Year</td>
<td>Specification</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1786-1983</td>
<td>Specification high strength deformed steel bars and wires for concrete reinforcement (Third revision)</td>
</tr>
<tr>
<td>1852-1985</td>
<td>Rolling and cutting tolerances for hot rolled steel products (Fourth revision)</td>
</tr>
<tr>
<td>1863-1979</td>
<td>Hot rolled steel bulb flats (First revision)</td>
</tr>
<tr>
<td>1868-1996</td>
<td>Specification for anodic coating on aluminium and its alloys (Third revision)</td>
</tr>
<tr>
<td>1948-1961</td>
<td>Specification for aluminium doors, windows and ventilators</td>
</tr>
<tr>
<td>1949-1961</td>
<td>Specification for aluminium windows for industrial buildings</td>
</tr>
<tr>
<td>2016-1967</td>
<td>Specification for plain washers (First revision)</td>
</tr>
<tr>
<td>2062-2006</td>
<td>Specification for hot rolled low, medium and high tensile structural steel (Sixth revision)</td>
</tr>
<tr>
<td>2314-1986</td>
<td>Specification for steel sheet piling sections (First revision)</td>
</tr>
<tr>
<td>2502-1963</td>
<td>Code of practice for bending and fixing of bars for concrete reinforcement</td>
</tr>
<tr>
<td>2721-2003</td>
<td>Specification for galvanised steel chain link fence fabric (Second revision)</td>
</tr>
<tr>
<td>2751-1979</td>
<td>Code of practice for welding of mild steel bars used for reinforced concrete construction (First revision)</td>
</tr>
<tr>
<td>3016-1982</td>
<td>Code of practice for fire precautions in welding and cutting operations (First revision)</td>
</tr>
<tr>
<td>3063-1994</td>
<td>Specification for single coil rectangular sections spring lock washers (Second revision)</td>
</tr>
<tr>
<td>3443-1980</td>
<td>Crane rail sections (First revision)</td>
</tr>
<tr>
<td>3502-1994</td>
<td>Specification for steel chequered plates (Second revision)</td>
</tr>
<tr>
<td>3908-1986</td>
<td>Aluminium equal leg angles (First revision)</td>
</tr>
<tr>
<td>3909-1986</td>
<td>Specifications for aluminium unequal leg angles (First revision)</td>
</tr>
<tr>
<td>3921-1985</td>
<td>Aluminium channel (First revision)</td>
</tr>
<tr>
<td>3954-1991</td>
<td>Hot rolled steel channel sections for engineering purposes dimensions (First revision)</td>
</tr>
<tr>
<td>4000-1992</td>
<td>Code of practice for high strength bolts in steel structures (First revision)</td>
</tr>
<tr>
<td>4351-2003</td>
<td>Specification for steel doors frames (Second revision)</td>
</tr>
<tr>
<td>4923-1997</td>
<td>Hollow Steel sections for structural use : Specifications</td>
</tr>
<tr>
<td>4948-2002</td>
<td>Specification for welded steel wire fabric for general use (Second revision)</td>
</tr>
<tr>
<td>5384-1985</td>
<td>Aluminium I Beam (First revision)</td>
</tr>
<tr>
<td>5523-1983</td>
<td>Method of testing for anodic coating on aluminium and its alloys (First revision)</td>
</tr>
<tr>
<td>6248-1979</td>
<td>Specification for metal rolling shutters and rolling grills (First revision)</td>
</tr>
<tr>
<td>6445-1985</td>
<td>Aluminium tee sections (First revision)</td>
</tr>
<tr>
<td>6639-2005</td>
<td>Specification for hexagon head bolts for general steel structures (First revision)</td>
</tr>
<tr>
<td>7205-1974</td>
<td>Safety code for erection of structural steel work.</td>
</tr>
<tr>
<td>7215-1974</td>
<td>Tolerances for fabrication of steel structures.</td>
</tr>
<tr>
<td>7452-1990</td>
<td>Specification for hot rolled steel sections for doors, windows and ventilators (Second revision)</td>
</tr>
<tr>
<td>9595-1996</td>
<td>Recommendation for metal arc welding of carbon and carbon manganese steel (First revision)</td>
</tr>
<tr>
<td>10019-1981</td>
<td>Specification for mild steel stays and fasteners</td>
</tr>
<tr>
<td>10521-1883</td>
<td>Specification for collapsible gate</td>
</tr>
<tr>
<td>12753 - 1989</td>
<td>Electro galvanized coatings on round steel wire specifications.</td>
</tr>
<tr>
<td>12778-2004</td>
<td>Hot rolled parallel, flange steel sections for beams, columns and bearing piles dimensions and section properties (First revision)</td>
</tr>
<tr>
<td>12843-1989</td>
<td>Tolerances for erection of steel structure</td>
</tr>
<tr>
<td>13871 - 1993</td>
<td>Specification for powder coatingss</td>
</tr>
</tbody>
</table>

**CAST IRON WORK**

**10.2 Cast Iron Work**

Casting shall be from cast iron of grade FG 150 conforming to IS: 210 -1978, specification for grey iron castings. The castings shall be sound, clean and free from porosity, blowholes, hard spots, cold shuts (i.e.,
irregularities due to casting at too low a temperature), distortion and other harmful defects. They shall be well dressed and fettled; accurately moulded in accordance with the pattern / drawing and shall be of uniform thickness except where the design necessities variation. Abrupt changes in the section: of adjoining members shall be voided as far as possible. Unless otherwise indicated edges of castings shall be rounded and integral angles finished with an angle fillet. No welding or repairs shall be carried out, unless otherwise indicated.

10.3 Structural Steel Work

Structural steel shall conform to

(a) Structural steel (fusion welding quality) ‘fe 410-W’ conforming to IS 2062-2006, Specification for structural steel (fusion welding quality). Fe 310-0 steel may be used for general purpose such as door and window frames, window bars, grills, steel gates, handrails, tie bars etc.

10.3.1 Freedom from Defects:

All finished steel shall be well and cleanly rolled to the dimensions, sections and weights specified. The finished material shall be reasonably free from cracks, surface flaws, laminations, rough, jagged and imperfect edges, and all other harmful defects. Minor surface defects may be removed by the manufacturer by grinding provided that the thickness is not locally by more than 4 percent with a maximum of 3 mm.

10.3.2 Structural steel of different sections, sizes and lengths shall be stacked separately. For each classification of steel separate areas shall be earmarked. Steel shall be marked with distinct painting marks for easy identification. All steel shall be so stored that it is always at least 15 cm above the ground level In case of long storage suitable protective measures shall be taken to prevent scaling and rusting.

10.3.3 Tolerances

Rolling and Cutting tolerances shall be as per IS 1852.

10.4 Chequered Plates

Chequered plates shall be as per requirements given in IS 3502-1994 Specification for steel chequered plates, Pattern of chequered plates shall be as directed. Plates shall be cleanly rolled and shall be reasonably free from harmful surface defects such as cracks, surface flaws, imperfect edges, etc. thickness of chequered plates specified shall be exclusive of the raised portion.

10.5 BLANK

10.6 Bolts Nuts and Washers

10.6.1 Bolts and nuts shall be conforming to the relevant requirements given in the following IS specifications and as indicated:

(a) IS1363-2002 (Parts 1 to 3) Specification for hexagon head bolts, screws and nuts Of product grade ‘C’ (Size M5 to M64)

(b) IS 1367 (Parts 1 to 20) Technical supply conditions for threaded fasteners.

(c) IS 6639-2005 Specification for hexagon head bolts, for steel structures

10.6.2 The heads shall be forged. in one piece with the bolts and the nuts shall, be neatly made with the hole truly in the centre. The threads shall be full, true and deep. The heads and nuts shall be hexagonal unless square heads and nuts are specially indicated. Bolts and nuts Shall be cleanly finished and shall be sound and free from defects, which may affect their serviceability. Bolts and nuts shall be suitably protected against corrosion.

10.6.3 Washers :

Plain washers shall be of steel conforming to IS 2016-1974. Specification for plain washers: Spring washers shall conform to IS 3063-1994, specification for single coil, rectangular section spring washers for bolts; nuts and screws. The washer shall be free from cracks, burns, pits to other defects. The hole shall be reasonably concentric, with the outer periphery. All sharp edges shall be removed.
10.7 Electrodes

Electrodes for metal arc welding of mild steel shall be as per IS 814-2004, Specification for covered electrodes for metal arc welding of structural steel Joints in materials above 20 mm thick and all important connections shall be made with low hydrogen electrodes. The mechanical properties of the weld deposit shall be such as to satisfy all the requirements such as tensile strength, elongation and impact strength of the parent metal.

10.8 Workmanship Generally

Structural steel work riveted, bolted or welded shall be carried out described in IS 800-1984, code of practice for use of structural steel in general building construction.

Note: The Contractor shall prepare the shop Drawings indicating all details regarding cutlength, weld, bolts, joints, splicing, position etc., for the approval of the consultant before providing for any fabrication. All connections, bolts, welds etc., shall be neatly described in the drawing. Approval of shop Drawings by the consultant shall not relieve the Contractor from the responsibility for correctness of the dimensions and adequacy.

10.8.1 Straightening and bending:

All material shall be straight and if necessary, before being worked shall be straightened and flattened by pressure, unless required to be of curvilinear form and shall be free from twists. Straightening of steel by hammer blows is not permitted. All bending and cutting shall be carried out in cold condition, unless otherwise directed, in such manner as not to impair the strength of the metal.

10.9 Cutting and Machining

Member shall be cut mechanically by saw or shear or by oxyacetylene flame. All sharp rough or broken edges and all edges of joints which are subjected to tensile or oscillating stresses shall be grounded. No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene pores shall be cleaned of impurities and slag prior to assembly. Cutting tolerance shall be as follows:

(a) For members connected at ends +/- 1 mm.
(b) Elsewhere +/- 3 mm.

10.9.1 When compression members depend upon contact surfaces for stress transmission, then ends of columns, caps and bases together with gussets, angles and channels (after riveting/ welding together) shall be accurately machined so that the parts connected butt over the entire surfaces of contact. Columns at bases or at caps or at butt joints need not be machined.

10.10 Holes

All holes shall be accurately marked and drilled. Holes through more than one thickness shall preferably be drilled together after the members are assembled and tightly clamped or bolted together. In such cases, if required, these parts shall be separated after drilling and burrs removed. For thickness of materials less than 16 mm the holes may be punched 3 mm less in diameter then the required size and be reamed to the full diameter after assembly. Finished holes for rivets and black bolts shall be not more than 1.5 mm (2.0 mm for rivets and bolts or diameter more than 25 mm) in diameter larger than the diameter of rivets and bolts passing through them. All matching holes for rivets shall be so prepared that a gauge 0.8 mm diameter less than the hole can pass steeley through the members assembled for riveting. Holes other than those required for close tolerance may be punched full size through material not over 12 mm thick.

10.10.1 All holes shall have their axis perpendicular to the surface bored through. Holes through two or more members shall be truly concentric. No rivet or bolt hole shall be nearer the edge of the member than distance equal to its own diameter. Holes shall not be formed by gas cutting process.

10.11 Assembly

Before assembly the contact surfaces shall be painted with a heavy coat of pure zinc chromate red oxide primer including surface preparation.

10.11.1 Laying Out:
Steel structure shall be laid out on a level platform to full scale and to full size or in parts as shown on working drawings or as directed by EIC. Wooden templates 12 mm to 19 mm thick or metal sheet templates shall be made to correspond to each member and part, rivet holes shall be marked accurately on them and drilled. The templates shall be laid on the steel members and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting. The base of steel columns and the positions of anchor bolts shall be carefully set out.

10.11.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified cambers, if any, are provided. All box sections shall be carefully set out.

10.11.3 Assembly shall be done by using assembly fixtures, jigs and stands, which facilitate high quality assembly with proper safety. Mis-alignment and distortion of parts after assembly shall not be allowed; only thoroughly straightened parts free from burrs, grease, rust, etc, shall be allowed for assembly.

10.11.4 Temporary connection of parts during assembly shall be done in the following way:

(a) For welded structures joining shall be done by means of tack weld, fastening devices and fixtures.

(b) For riveted and bolted structures joining shall be done by adequate number of bolts. If tack welding is permitted, in such cases the same shall be removed after the work is over.

(c) For riveted structures in which holes are to be drilled after assembly, joining shall be done by appropriate fixtures.

10.11.5 Tack welding shall be done on the sides and along the line of the weld. Tack weld dimension shall be minimum. Tack welding shall be carried out with similar electrodes as the final welding and the tacks shall completely fuse with the final weld metal.

10.11.6 In case splicing is necessary, the individual members shall be spliced first before assembly and before final welding with other members.

10.11.7 For riveted structures, members shall be well tightened by assembly bolts in every third hole maximum distance between bolts shall not exceed 500 mm. To prevent stiffening, drift pins shall be used 30 percent of the assembly bolts. After tightening, the gap between members to be jointed shall be checked by 0.2 mm thick feeler gauge which should not go inside by more than 2 mm, looseness of bolts shall be checked by tapping with a test hammer.

10.13 **Bolting**

Bolt head and nuts shall be of such length as to project one clear thread beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

10.13.1 Round washers shall be placed under the heads and nuts of permanent bolts. Maximum two washers for one nut and one for each bolt head shall be used. Bolt threads shall be outside the limits of joining members and unthreaded portion of bolt shall not be outside the washer.

10.13.2 Where there is risk of the nuts being removed or becoming loose due to vibration or reversal of stresses, these shall be secured from slackening by the use of lock nuts or spring washers, as directed by the EIC.

10.13.3 Bolts, nuts and washers shall be thoroughly cleaned and dipped in double linseed oil before use.

10.13.4 Quality of tightening of bolts shall be inspected by tapping them with a hammer. The bolt shall not be shaken or shifted.

10.13.5 The bolts shall be tightened starting from center of the joint towards the edge.

10.14 **Welding**
10.14.1 Welding shall be done by metal arc process unless otherwise permitted by the EIC, in writing, in accordance with IS 816-1969 Code of practice for use of metal arc welding of general construction. in mild steel, and IS 9595-1996 Recommendation of Metal .arc welding, regarding workmanship welding method, welding procedure with suitable electrodes and wire flux, combinations, quality of welds, correction of weld faults etc.

10.14.2 *Preparation of members for welding:*

10.14.2.1 Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axis, nodes etc)

10.14.2.2 Sharp edges, rust of cut edges, notches, irregularities and fissures to ensure due to faulty cutting shall be chipped or ground or filed over the length of the affected area deep enough to remove faults completely.

10.14.2.3 Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint.

10.14.2.4 Generally, no special edge preparation shall be required for members under 8 mm thick.

10.14.2.5 Edge preparation (beveling) denotes cutting of the same so as to result in V, X, K or U seam shapes as per IS 9595.

10.14.2.6 The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust of dirt-covered parts be assembled. Joints shall be kept free from any foreign matter, likely to get into the gaps between members to be welded.

10.14.2.7 Before assembly, the edges to be welded as well as adjacent areas extending for at least 20 mm shall be cleaned (until metallic polish is achieved)

10.14.2.8 When assembling members proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structures.

10.14.2.9 The elements shall be got checked and approved by the EIC before assembly.

10.14.2.10 The permissible tolerances for assembly of members preparatory to welding shall be as per IS 9595.

After the assembly has been checked, temporary tack welding in position shall be done by electric welding, keeping in view finished dimensions of the structure.

Preheating of members to be joined to be carried put as per standards wherever necessary.

**Butt Welds:**

The form of joint, angle between fusion faces, gap between parts and the welding procedure shall be such that welded joint shall comply with the design requirements. The ends of butt joints in plate shall be welded so as to provide full throat thickness. In the gas-welded condition, the weld face shall be proud of the surface of the parent metal. Where a flush surface is required, the excess metal shall be dressed off. Where no dressing is to be carried out, the permissible weld profile shall be as specified in the relevant IS.

For butt weld, where these are to be welded for both sided, certain welding procedures allow this to be done without back going, but where complete penetration cannot be achieved, the back of the first run shall be gouged out to clean sound metal before welding is started on the gouged outside.

**Fillet Welds:**

A fillet weld as deposited shall be not less than the specified dimensions indicated as throat thickness and/or leg thickness taking into account penetration process or partial penetration. For concave fillet welds the actual throat thickness shall be not less than 0.7 times the specified leg length. For convex fillet welds,
the actual throat thickness shall be not less than 0.9 times the specified leg length.

**Preparation of joint Faces:**

If preparation or cutting of material is necessary, this shall be done by shearing, chipping, grinding, machining, thermal cutting. When shearing is used the effect of work hardening shall be taken care of to ensure that there is no cracking of the edges. Removal of 1 mm to 2 mm from a cut face normally eliminates the layer of hardness.

**Fusion Faces:**

Fusion faces and adjustment surfaces shall be free from cracks, notches or other irregularities which might be the cause of defects or would interfere with the deposition of the weld. They shall also be free from heavy scale, moisture, oil, paint and any other substances which might affect the quality of weld or impede the progress of welding.

**Assembly for Welding:**

Jigs and manipulators should be used, where practicable, so that the welding can be carried out in the most suitable position. Jigs shall maintain the alignment with the minimum restraint so as to reduce the possibility of lock in stresses.

**Alignment of Butt Joint:**

The root edges or root faces of butt joints shall not be out of alignment by more than 25 percent of the thickness of the thinner material for material up to 12 mm thick or by more than 3 mm for thicker material. For certain applications closer tolerances may be necessary for proper alignment.

**Fit up of parts jointed by fillet welds:**

The edges and surfaces to be jointed by fillet welds shall be in close contact as possible since any gap increases the risk of cracking but in no case should be gap exceed 3 mm.

**10.14.10 Tack Welds:**

Tack welds shall be not less than the throat thickness or leg lengths of the root run to be used in the joint. The length of the tack weld shall not be less than four times the thickness of the thicker part or 50 mm whichever is smaller. If smaller tack welds are desired, these shall be so indicated.

Where a tack weld is incorporated in a welded joint, the shape of the tack shall be suitable for incorporation in the finished weld and it shall be free from cracks and other deposition faults.

**10.14.11 Protection from Weather:**

Surface to be welded shall be dry. When rain or snow is falling or during periods of high wind, necessary precautions shall be taken for outdoor welding. Warming shall be carried out at all ambient temperatures below 10°C.

**10.14.12 Inter-Run Cleaning:**

Each run of weld bead and each layer of weld shall be thoroughly cleaned of slag, spatters, etc., before depositing subsequent bead or weld with particular reference to thorough cleaning of toes of the welds. Visible defects such as cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run or layer of weld.

**10.14.13 Welding Procedure:**

10.14.13.1 Welding shall be carried out only by fully trained and experienced welders as tested and approved by the EIC.

10.14.13.2 Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS 823. The nature of test for performance qualification for welders shall commensurate with the
quality of welding required on this work as judged by the EIC.

10.14.13.3 The steel structures shall be automatically, semi-automatically or manually welded.

10.14.13.4 Welding shall be done only after the checks shown under clause 10.15 have been carried out.

10.14.13.5 Welding procedures and tests for welders shall be conducted as per IS 9595 and approved by the EIC

10.14.13.6.1 The welder shall mark with his identification mark on each element welded by him.

10.14.13.7 When welding is carried out in open air steps shall be taken to protect the places of welding against wind or rain. The electrodes wire and parts being weld on shall be dry.

10.14.13.8 Before beginning the welding operation each joint shall be checked to assure that the parts to be welded are clean and root gaps provided as per IS 9595

10.14.13.9 For continuing the welding of seams discontinued due to some reasons the end of the discontinued seam shall be melted in order to obtain a good continuity. Before resuming the welding operation the groove as well as the adjacent parts shall be well cleaned for a length of approximately 50 mm.

10.14.13.10 For single butt welds (in V,1/2V or U) and double butt welds (in K, double U, etc) the rewelding of the root butt is mandatory but only after the metal deposition on the root has been cleaned by back gouging or chipping.

10.14.13.11 The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any method.

10.14.13.12 For multi layer welding before welding the following layer, the formerly-welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed.

10.14.13.13 The order and method of welding shall be so that:

(a) No unacceptable deformation appeared in the welded parts

(b) Two margin is provided to compensate for contraction due to welding in order to avoid any a high permanent stresses.

10.14.13.14 The defects in welds shall be rectified to IS: 9595 and as per instruction of EIC.

All weld shall be inspected by Dye Penetration before painting, any weld found to be defective shall be cut by using either chipping hammer or any other means in such a manner that the adjacent material is not damaged.

10.14.14 Approval and Testing of welders:

The contractors shall satisfy the EIC that the welder is suitable for the work up on which they will be employed.

10.14.15 Weld instruction:

The weld seams shall satisfy the following:

a. shall correspond to design, shapes and dimensions

b. Shall not have any defects such as cracks, incomplete penetration and fusion under cuts, rough surfaces, burns, blow holes, and porosity etc beyond permissible

10.14.15.1 During the welding operation and approval-of finished elements inspection ant test shall be made as shown in table 1 below

<table>
<thead>
<tr>
<th>SL No</th>
<th>Inspection of test</th>
<th>Coverage</th>
<th>Procedure</th>
<th>Evaluation and remedy of defects</th>
</tr>
</thead>
</table>

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 81 of 494
10.14.15.2 The mechanical characteristics of the welded joints shall be as in IS: 9595

10.14.16 Quality of welds and corrections:

Welded joints shall be free from defects that would impair the service performance of the construction. All welds shall be free from incomplete penetration, incomplete fusion; slag inclusion, burns, unwelded craters, undercuts and cracks in the weld metal or in the heat affected zone, porosity, etc. Unacceptable undercutting shall be good by grinding. In case of shrinkage cracks, cracks in parent plate and crater, defective portions shall be removed down to sound metal and re-welded. Whenever corrections necessitate the deposition of additional weld metal, electrode of a size not exceeding 4mm may be used. Rectification of welds by caulking shall not be permitted.

10.15.17 Cleaning

All welds shall be cleaned of slag and other deposits after completion; till the work is inspected and approved, painting shall not be done.

10.15.18 Plaining of Ends :

10.15.18.1 Plaining of ends of member like column ends shall be done by grinding where so specified.

10.15.18.2 Plaining of butt welded member shall be done after these have been assembled and the edges be removed with grinding machine or file.

Shop Painting : Entire steel work with exception of bolts, nuta and machined surfaces after being thoroughly cleaned and shall be given shop coat of zinc chromate primer. Welds and adjacent parent material shall not be painted prior to the deslagging, inspection and approval.

10.15.18.3 The following tolerances shall be permitted on members that have been plained:
(a) The length of member having both end plained max + 2mm with respect to design.
(b) Level difference between plained surface = 0.3mm.
(c) Deviation between plained surface and member axis= max 1/5000.

10.15.19 Safety and Health

The Contractor shall ensure that the safety requirements and health provisions laid down in IS : 818-1968, Code of Practice for safety and health requirements in electric and gas welding and cutting operations, are complied with during welding operations. The Contractor shall also provide equipment for eye and face protection during welding as laid down in IS: 1179-1967. Fire precautions shall be taken in accordance with IS 3016-1982, Code of practice for fire precautions in welding and cutting operations.

10.15 Erection :

10.15.1 Erection work shall be performed in accordance with the general construction schedule. A scheme shall be worked before the commencement of the erection which shall also contain rules for safety precautions as detailed in IS: 7205-1974. Safety code for erection of structural steel works.
10.15.2 Anchor bolts for fastening of steel structures shall be set in designed positions and grouted along with foundations. Alternatively anchor bolts should be provided in the concrete foundation with bolt boxes and anchor channels for the purpose of flexibility and grouted after final alignment and levelling Column.

10.15.3 The gaps between the bearing surface of foundation and bottom of the structure to be erected shall be filled properly by cement grouting. Grouting shall be done after the verification and proper positioning of the structures but before encasing the structures with concrete if specified.

10.15.4 Damaged structural members shall be examined and rectified or replaced as directed.

10.15.5 The erected parts of the structures shall be stable during all the stages of erection; and structural elements to be erected shall be stable and strong to bear erection loads.

10.15.6 Working on the already erected structures is permitted only after they are finally fixed. Erection of structures of each tier for high structures shall be executed only after fastening of lower tier by the permanent or temporary fastening devices as per schedule of execution of work and certified for safety.

10.15.7 The joint and mating surface including the mating planes, strips and filler or spacers shall be cleaned of dust, rut and water.

10.15.8 Erected structural members shall be firmly fastened by bolts and drifts, permanent or provisional tacking, crossing bars and so on before the erection crane hook is removed.

10.15.9 The trusses shall be lifted only at nodes. The trusses above 12 m span shall not be singed at the apex, as it will develop compression stresses in the bottom tie member. It shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of suitable section. After the trusses are placed in position purlins and wind bracings shall be fixed as soon as possible. The end of truss which faces the prevailing winds shall be fixed with holding down bolts and the other end kept free to move. In case of small truss of span say up to 12 mm the free end of the truss shall be laid on steel plate as per design and the holes for holding down bolts shall be made in the form of oblong slot as to permit the free movement of the truss end. For large spans, the free end of the truss shall be provided with suitable rocker and roller bearing where indicated.

10.15.10 Erection Joints:

While erecting, holes to be riveted shall be fitted with temporary bolts and drifts of diameter equal to those of the holes. It is necessary to install drifts for accurate matching of holes. Number of bolts and drifts shall not be less than 40 percent of total number of holes. Forces applied to drifts shall be same as approved for rivets. Number of drifts shall be 10 percent of number of holes.

10.15.11 The number, size and length of tack welds in erection forces shall be as indicated. For the erection joints which do not bear the erection forces the length of tack welds shall be minimum 10 percent of tube designed weld length of the joint.

10.15.12.1 Welding, riveting and final fastening of permanent bolts shall be done only after the inspection of the structural elements for their positions. Head bolts and nuts shall perfectly be in touch with the surfaces of structures and washers.

10.15.13 Tolerance Allowed in Erection;

10.15.13.1 Building without crane;

The maximum tolerance for line and level of steel structure shall be ±3 mm on any part of the structure. The structure shall not be out of plumb more than 5 mm on each 10 meter section in height and not more than 8 mm per 30 metre section. These tolerances shall apply to all parts of structure unless otherwise specified.

10.15.13.2.1 Tolerance allowed in erection of steel structure containing cranes shall be as per following table:
<table>
<thead>
<tr>
<th>Component</th>
<th>Table</th>
<th>Tolerance Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Columns and Roof Posts</td>
<td>(a) Shifting of column's axis at foundation level with respect to building line: (i) In longitudinal direction (ii) In lateral direction</td>
<td>+/-5 mm +/-5 mm</td>
</tr>
<tr>
<td></td>
<td>(b) Deviation of both major column axis from vertical between Foundation and other member connection levels: (i) For a column upto and including 10m height, (ii) For a column greater than 10m but less than 40m height</td>
<td>+/-5.00 mm from true vertical +/-5 mm from true vertical for any 10M length measured between connection levels but not more than +/-8.00mm for 30 M length</td>
</tr>
<tr>
<td></td>
<td>(c) For adjacent pairs of columns across the width of the building prior to placing of truss.</td>
<td>+/-5.00 mm on true span</td>
</tr>
<tr>
<td></td>
<td>(d) For any individual column deviation of any bearing or resting level from levels shown on drawings.</td>
<td>+/-5.00 mm</td>
</tr>
<tr>
<td></td>
<td>(e) For adjacent pairs of columns either across the width of buildings or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.</td>
<td>+/-5.00 mm</td>
</tr>
<tr>
<td>Truss</td>
<td>(a) Deviation at centre of span of upper chord member from vertical plane running though centre of bottom chord. (b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.</td>
<td>1/500 of the span or 10mm whichever is less 1/250 of depthon truss or 20mm whichever is less</td>
</tr>
</tbody>
</table>

**STEEL REINFORCEMENT**

**10.16 Steel Reinforcement for concrete**

Steel Reinforcement shall be of mild steel plain bars, high strength deformed bars manufactured by thermo mechanical treatment process (TMT), steel wire fabrics and of grade / types as indicated.

10.16.1 Mild steel plain bars shall be grade I or grade II as indicated and conforming to IS 432 (part I) - 1982, Specification for mild steel and medium tensile steel bars. Alternatively mild steel bars shall be of grade E 250 conforming to IS 2062.

10.16.2 High strength Deformed Bars shall be produced by thermo mechanical treatment process (TMT) and shall be of grade Fe 415, Fe 500 or Fe 550 as indicated meeting all requirements confirming to IS 1786 - 1985 Specification for high strength deformed bars and wires for concrete reinforcement.


**10.16.4 Tolerance on size of Reinforcement Bars:**

The tolerance on diameter of the mild steel bars will be +/- 0.5mm for bars upto and including 25mm dia with a total margin of 1 mm, and +/- 0.75mm for bars above 25mm dia with total margin of 1.5mm. The tolerance on the diameter in the case of coiled round bars shall be +/- 0.5mm upto and including 12mm diameter with a total margin of 1 mm Measurement shall be taken at point sufficiently away from the ends ensuring exclusion of heavy ends.

**10.16.5 Tolerance on Weight:**

The tolerance on weight of plain and deformed round shall be ±4 percent with a total margin of 8 percent
for bars up to and including 8 mm diameter and +/- 2.5 percent for bars over 8 mm diameter with a total margin of 5 percent.

Tolerances on weight of fabric reinforcement shall be +/- 6 percent

10.16.6 Freedom from defects:

All finished bars shall be well and cleanly rolled to the dimensions and weights specified: these shall be sound and free from cracks, surface flaws, laminations and rough, jagged and imperfect edges and other defects and shall be finished in a workmanlike manner.

10.16.7 Steel reinforcement shall be stored as to prevent distortion and corrosion. Any reinforcement that has “deteriorated or corroded or is considered defective by the EIC shall not be used in the work. Bars of different classification, sizes, and lengths shall be stored separately to facilitate use in such sizes and lengths so as to minimize waste in cutting from the standard lengths

10.17 Bends and Hooks forming end Anchorages

10.17.1 In the case of binders, stirrups, links, etc the straight portion beyond a curve at the end shall be not less than 8 times the nominal size of the bar.

10.17.2 Bars specified to be formed to radii exceeding those given in the table X of IS2502. Code of practice for bending and fixing of bars for concreting need not be bent but the required curvature may be obtained during the placing.

10.17.3 Bending of bars:

Bars shall be bent to shape cold except that bars larger than 25 mm in size may be bent hot at cherry red heat (not exceeding 850°C) Hot bar shall not be cooled by quenching. A bar which shows any sign of cracks at a bend shall be rejected.

10.18 Splicing:

Where bars required are longer than those carried in stock, splices shall be provided as far as possible, away from the section of maximum stress and be staggered. Lap splices shall be considered as staggered if the centre to centre distance of the splices is not less than 1.3 times the lap length. The use of short length bars shall not be permitted. IS 456-1978, Code of practice for plain and reinforced concrete recommends that splices in flexural members should not be at section where the bending moment is more than 50 percent of the moment of resistance; and not more than half the bars shall be spliced at a section.

10.18.1 Lap Splices:

Lap splices shall not be used for bars larger than 36 mm dia, larger diameter bars may be welded, in cases where welding is not practicable, lapping of bars larger than 36 mm dia may be permitted in which case additional spirals shall be provided around the lapped bars.

10.18.2 Lap length including anchorage value of hooks for bars in flexural tension shall be not less than development length (calculated as per IS 456) or 30 diameter whichever is greater and for direct tension shall be not less than two times development length (calculated as per clause 26.2.1 of IS 456) or 30 diameter whichever is greater. Lap length in compression shall be not less than development length in compression (calculated as per IS 456) or 24 diameter whichever is greater. When bars of two different diameters are to be spliced the lap length shall be calculated on the basis of diameter of the smaller bar. Other provisions of IS 456 shall also be followed.

10.18.3 End bearing splices shall be, used only for the bars in compression. The ends of the bars shall be square cut and concentric bearing ensured by suitable devices.

10.18.4 When larger diameter bars have to be welded to avoid congestion rather than lapped for splicing, the method of welding shall be as directed. The location of staggered weld at heights or position shall be convenient for welding.
10.18.5 Spiral Reinforcement:

Spirals shall be provided with one and a half extra turns at both top and bottom. Where necessary to splice the spiral it shall be done by a lap of one and a half turns or by shop welding.

10.18.6 Placing and fixing of bars

Reinforcement shall be placed in position as per detailed design drawing and shall be secured at that position. In case of delay occurring between fixing of reinforcement and concreting, the position of the reinforcement shall be checked prior to concreting. Bars crossing each other shall be secured by binding wire (annealed) of size not less than 0.9 mm and conforming to IS 280-1978. Specification for mild steel wire, in such a manner that they will not slip over each other at the time of fixing and concreting. Every compression bar shall be tied at least in two perpendicular directions.

10.19.1 Cover Blocks:

Cover blocks generally of PVC or cement mortar. shall be used to ensure the required cover for the reinforcement. The mortar or concrete used for the cover blocks or rings shall, be not leaner than the mortar or concrete in which they would be embedded.

10.19.2 Spacers:

Where multiple rows of reinforcement are provided distances between successive rows shall be properly maintained while concreting by providing suitable spacer bars.

10.19.3 Placing Reinforcement:

All mill scale, loose or scaly rust, oil and grease or any coating that will destroy the bond shall be thoroughly cleaned off the steel reinforcement with a stiff wire brush or approved means before it is placed in forms. Steel reinforcement when placed in the forms shall be properly braced, supported, or otherwise held firmly in position so that placing and ramming/vibrating of concrete does not displace it.

10.19.4 It shall be ensured that all reinforcement can be properly placed. Congestion of steel shall be avoided at points where members intersect.

10.19.5 Tolerance in Placing of reinforcement:

Unless otherwise indicated, reinforcement shall be placed within following tolerance.

a) For effective depth 200 mm or less = +/−10mm
b) For effective depth more than 200 mm = +/−15mm

The cover shall in no case be reduced by more than 1/3 of specified cover or 5 mm whichever is less.

10.20 Steel Wire Fabric Reinforcement

Hard drawn steel fabric shall conform to IS 1566-1982 specification for hard drawn steel wire fabric for concrete reinforcement, MESH size, weight, size of wire for square and oblong welded wire fabric shall be indicated. The fabric shall be formed by spacing the main and the cross wire, which shall be fixed at the point of inter-section by electric welding.

"Since fabric is supplied in long rolls it is rarely necessary to have a joint of the main wires. In structural slab laps in regions, of maximum stress shall be avoided. When splicing of welded wire fabric is to be carried out, lap splices of wires shall be made so that overlap measured between the extreme cross wires shall be not less than the spacing of Cross wires plus 10 cm. For edge laps a lap of 5 cm shall be provided.

10.21 Welding of Reinforcement

Welding of bars where indicated or agreed to by the EIC, in writing, in lieu of lapping shall be done in accordance with IS 2751-1979 code of practice for welding of concrete construction. Welding in general shall be done as described for structural steel work.
10.21.1 Bars up to and including 20 mm dia shall be lap welded and those larger than 20 mm dia shall be butt-welded. In case of lap welds, the length of lap shall be five times the dia or 100 mm whichever is greater. The throat thickness shall not be less than 3 mm for bars up to 16 mm dia and 5 mm for bars over 16 mm dia and up to 20 mm dia.

**Butt Welding**

Where it is not possible to rotate bars for welding in flat position the axis of the bars shall be horizontal and the respective axis of the welds shall be vertical. The edge preparation for inclined bars shall be such that welding is done only on sides. All the bars to the butt-welded shall be aligned and set up in position with their axis in one straight line. This may be done in a jig or by means of a clamp or by using guides. Rotation of the bars shall be avoided, until they are adequately welded.

**Lap Welding**

Edge preparation is not necessary for lap welds.

**Finish:**

The profile of the welds shall be uniform, slightly convex and free from overlap at the toes of the welds. The weld face shall be uniform in appearance throughout its length. The welded joint shall be free from undercut. The joints in the weld run shall be as smooth as practicable and shall show no pronounced hump or crater in the weld surface. The surface of the weld shall be free from porosity, cavities and trapped slag.

**Steel Rolling Shutters**

Steel rolling shutters shall be of approved make and shall conform to the requirements of IS 6248-1979 specification for metal rolling shutters and rolling grills. The size of the rolling shutters (denoted by clear width and clear height) shall be as indicated. The position of fixing of the rolling shutter shall be as indicated viz. inside or outside or within jambs; with projecting or embedded guide channels and above or below the soffits.

Rolling shutters shall be gear operated type with bevel gear box and crank handle.

**Curtain**

The curtain shall be built up of inter-locking lath sections formed from cold rolled steel strips 1.20 mm thick for all shutters unless otherwise specified. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the center with a bridge depth of not less than 12 mm. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm between rolling centers, unless otherwise specified. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends.

**Lock Plate:**

A fabricated lock plate of riveted construction made of mild steel sheet of not less than 3.15 mm thickness, reinforced with mild steel angle section of not less than 35x35x5 mm size at the bottom, shall be interlocked with bottom most lath Section of curtain so as to provide contact against the sill, when closed. The lock plate shall be fitted with sliding bolts, with arrangements for locking with pad locks and also pulling handles of mild steel, one handle for width upto 2.5 m and two handles for widths of above 2.5 m pulling handle shall be fixed on both the interior and exterior side of the lock plate.

**10.22.4 Guide Channels:**

The guide channels shall be of mild steel deep channel section and of rolled, pressed or built up construction. Thickness of sheet shall not be less than 3.15 mm. The curtain shall project into the guide channel at least 40 mm up to 3.5 mm width and 60 mm for greater widths. There shall be a clearance of 10 mm minimum between the guide wall and end clips of the curtain. Minimum depth of the guide channels shall be as under:
**10.22.5 Bracket Plate:**

It shall be fabricated out of mild steel sheet of 3.15 mm minimum thickness in case of manually operated shutters, and 6 mm minimum thickness in case of mechanically operated shutters. The bracket plate may be of hexagonal square or circular contour. In case of manually operated shutter, extra tying in the bracket plate to the guide channel shall be provided by means of a square bar not less than 20 mm size. An angle iron 40x40x6 mm split at one end shall be firmly riveted or welded at the top line of the bracket. The angle shall extend at least 20 cm from the edge of the bracket plate. This angle shall be grouted firmly into the wall with the split end of the angle well buried in concrete. A stopper made out 40x6 mm M.S flat is bolted on to the square bar so that the lock plate be arrested, not going beyond the limit.

**10.22.6 Roller**

Recommended size, of pipes for suspension shafts for various widths of rolling shutter are as follows;-.

<table>
<thead>
<tr>
<th>Width</th>
<th>Size of pipe (nominal bore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 2 m</td>
<td>32mm</td>
</tr>
<tr>
<td>Upto 3 m</td>
<td>40mm</td>
</tr>
<tr>
<td>Upto 6 m</td>
<td>50 mm</td>
</tr>
</tbody>
</table>

The suspension shaft shall be provided with steel or preferably cast iron pulleys and helical wire spring or flat spiral springs for counter balancing the weight of the shutter adequately. When the width of shutter is greater than 3.5 m the pulleys shall be interconnected with a cage formed out of MS flats of at least 32x 6 mm and MS dummy ring made of similar flats so that the torque is distributed uniformly. In such cases self aligning two row-ball bearing shall be provided with special cast iron casting at the extreme pulleys at either ends, where indicated.

The caging rings shall have a minimum spacing of 15 cm and there shall be at least 4 nos. flat running through length of the roller.

**10.22.7 Hood Covers:**

Hood covers shall be made of mild steel sheets 1 mm thick. They shall be hexagonal square or circular contour depending on the contour of the bracket plate. The cover shall be properly stiffened with angle / flat stiffeners at top and bottom edges. The hood covers shall be fixed to the bracket plate.

**10.22.8 Gears, Worms etc:**

All gears, worms etc, used in the assembly of the rolling shutters shall be machine cut. Worm gear wheel shall be of high-grade cast iron or mild steel. The worms shall be of mild steel.

**10.22.9 Safety Devices:**

For width upto 2.5 m a properly fabricated and reinforced bottom, lock shall be provided to give protection. For width above 2.5 m in addition, both anchoring rods and central hasp and staples shall be provided. The pipes for the anchoring rods shall be embedded in the sill so as not to project above the sill surface.
Anchoring rods shall be provided at the rate of one per extra 2.5 m width or a part thereof of above a clear width of 2.5 m. The hasp shall be grouted on the ground so as to be level with the sill.

10.22.10 Wicket Doors:

Where indicated, wicket door of 600x1200 mm size for ordinary use and 900x1800 mm size for large installation shall be provided in the rolling shutters. The wicket door shall be robust construction and shall be fitted with a good lever lock operated by key, lockable both from inside and outside. The wicket doors shall be erected in such a way as not to foul with the main rolling shutters when opening or closing. The wicket door shall be swung clear of the opening before the rolling shutter is raised or lowered.

10.22.11 Safety Lever Locks:

Where indicated one pair of safety lever locks may be fitted on either ends of the bottom lock plate.

10.23 Rolling Grill

In situation where certain amount of ventilation combined with safety is required, for example transformer room, substation etc, the rolling shutter may have a small rolling grill portion either at top or at bottom or at both places as indicated. Rolling grill shall be built of cold rolled steel sheet links of 0.9 mm thickness assembled on tubes or rods. Grill may also be manufactured out of 8 mm dia MS round bars. Design of grill shall be as indicated.

10.24 Blank

10.25 Steel windows

Steel doors, windows and ventilators shall comply with IS 1038-1983, Specification or steel doors, windows and ventilators; except with regard to sizes, which shall be as indicated; and shall be of approved make. Rolled steel sections for fabrication shall conform to IS 7452-1990.

10.25.1 Fabrication:

Both fixed and opening frames shall be constructed of sections mixed at corners. The comers of frames shall be welded to form a solid fused welded joint. All frames shall be square and flat. The process of welding adopted may be flash butt welding or any other suitable method which complies with the requirements listed in the IS. Subdividing bars of the units shall be tenoned and riveted to the frames. Casements shall be fitted to their frames so as to provide continuous contact to weathering on the inside and outside and shall be secured in closed position by the fittings which shall have been properly adjusted. Windows and doors may have holes in the web of bars other than those required during manufacture and fixing. Fixing lugs shall have standard slot of 8mm wide for MS screw of 6 mm. dia and 12 mm long with square nuts.

10.25.2 For fixing steel hinges, slots shall be cut in the fixed frame and the hinges inserted inside and welded to the fame. The hinges shall be projecting type and not less than 65mm and not more than 75mm wide. The hinge pin shall be of electro-galvanised steel of suitable thickness. Where indicated, friction hinges shall be provided for side hung windows.

10.25.3 Side hung shutters

The handles for side hung shuters shall be of steel or of hot pressed brass, where indicated and shall be mounted on a steel handle plate. Thickness of handle shall not be less than 3 mm for mild steel and brass. The handle shall have a two point nose which shall engage with a steel/brass striking plate on the fixed frame in a slightly, open position as well as in a fast position. The boss of the handle shall incorporate a friction device to prevent the handle from dropping under its own weight and the assembly shall be so designed that the rotation of the handle may not cause it to unscrew from the pin. The strike plate shall be so designed and fixed in such a position in relation that with the latter bearing against its stop, there shall be adequate tight fit between the casement and the outer frames.
10.25.4 In cases where non-friction type hinges are provided, the windows shall be fitted with peg stays which shall be of steel and shall be 300 mm long with steel peg and locking brackets riveted or welded to the fixed frames. Side hinged casement fitted with friction hinges shall not be provided with peg stays.

10.25.5 Top Hung Ventilator
Steel butt hinges for top hung ventilators shall be riveted to fixed frame or welded to it after cutting a slot in it. Hinges to the opening frame shall be riveted or welded and cleaned off. Top hung casements shall be provided with a peg stay with three holes which when closed shall be held tightly by the locking bracket. The locking bracket shall either be fitted to the fixed frame or to the window.

10.25.6 Centre Hung Windows and Ventilators
Centre hung windows and ventilators shall be hung on two pairs of brass cup pivots, riveted to the inner and outer frames of the window to permit the window to swing to an angle of approximately 85 degree. The opening portion of the window shall be so balanced that it remains open at any desired angle under normal weather conditions. A brass spring catch shall be fitted in the centre of the top bar of the centre hung window and shall close into a mild steel or malleable iron catch plate. A brass cord pulley wheel in galvanized mild steel or malleable iron bracket shall be fitted at the sill of the window.

10.25.7 Door
Steel hinges unless otherwise indicated, shall be 50 mm projecting type. The hinge pin shall be of electrogalvanised steel. A mortice lock with not less than 4 levers shall be provided in the door where indicated. In the double leaf shutter concealed bolts at the top and bottom shall be of steel.

5.8 Weather Bar
Where fixed light occurs over external opening shutter, a push fit weather bar shall be provided.

10.25.9 Position of Holes
Outer frames shall be provided with fixing holes centrally in the web of the section.

10.25.10 Composite Units
Composite units shall consist of two or more units of doors, windows and ventilators jointed together with coupling sections made from MS sheet 1.6mm thick and of dimensions given in the IS. Mastic cement shall be applied between the junctions with the coupling sections to make the joints watertight.

10.25.11 Fixing steel Doors, Windows or Ventilators
Steel doors, windows or ventilators shall be fixed into prepared opening. They shall not be built-in as the walls go up. In case of brick work holes for fixing the lugs or holdfasts shall be cut 5 cm square and 5 cm to 10 cm deep, unless it is possible to put slotted lugs into joints. In the case of concrete or stone masonry, fixing lugs are recommended to be embedded in the masonry during construction at the appropriate places. Steel door, window and ventilator units shall be checked to ensure that they are square and working satisfactorily. The unit shall then be set in its opening by using wooden wedges at jambs, head and sill and shall be plumbed. The frame shall be squared and true and free from any warp and twist. The unit shall be put in position and the lugs screwed on tight. Every hole in the frame need not be fixed with a lug; some holes are incidental to manufacture and are not necessarily fixing holes. Lugs shall be placed in the specified position and then grouted into their holes with cement sand mortar 1:3; wedges round the frame shall be left in position until this cement has hardened and the lugs firmly set in. The gap between unit and surround shall then be filled with cement mortar 1:3. When fixing to flush surround without rendering, the 3 mm clearance round the frame shall be pointed with cement mortar 1:3. The plaster shall be applied to surrounds after the lugs have firmly set taking care to keep plaster clear of hinges and not to bring it too close to the opening frame of casement. Before applying the rendering, the joint of unit and mortar shall be pointed from the outside. Other details of fixing and the fixing procedure for composite doors, windows and ventilators shall generally be as described in IS 1081-1960, Code of practice for fixing and glazing of metal (steel & alUluminunum) doors, windows and ventilators.

10.27 Pressed steel frames

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
10.27.1 Steel frames for wooden shutters shall be pressed out of cold rolled mild steel sheets of 1.25 mm or 1.60 mm thickness as indicated and shall comply with requirements of IS 4351-2003. Specifications for steel door frames. Cold rolled mild steel sheet shall conform to IS 513. The size, type (profile) and dimensions of the frames shall be as indicated. Tolerance in the size of frames shall not vary by more than +/- 2 mm. The tolerance over the profile size shall be +/- 1 mm. Steel frames shall be of approved make.

10.27.2 Frames shall be either painted with two coats of ready mixed paint or power coated (conforming to IS 13871) as indicated.

10.27.3 Frames shall be filled with PCC 1:3:6.

**Mode of measurements:**

The length shall be measured in running meters correct to a cm. out to out of the frames including the embedded portion.

**10.28 Tee or Angles Iron Door, window and ventilator frames**

Tee or angles iron frames shall be made from mild steel tee or angle sections of the size’ as indicated. Steel shall be of grade E - 165 conforming to IS 2062-2006. The frame shall be fabricated in sections which have been cut and mitered. The corners of the frames shall be butt welded to form a true right angle. All frames shall be square and flat. Requisite number of the holes shall be made in the frame for fixing of fittings. Nuts shall be welded to the frame. Frames shall be fixed in the masonry opening with the lugs or any other arrangements as indicated.

**10.29 Steel sheeting, plain and corrugated**

Galvanized steel sheet, plain or corrugated shall comply with the requirements of IS 277-2003, specification for galvanized steel sheets, plain or corrugated. The grade of galvanizing shall be as indicated:

<table>
<thead>
<tr>
<th>Grade of coating</th>
<th>Minimum average mass of coating (Total both sides) (Triple spot test) gm/ m2</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

The following are recommended grades of zinc coating for the various thickness of sheets:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Grade of coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.18 to 0.28mm (both inclusive)</td>
<td>200</td>
</tr>
<tr>
<td>0.30 to 0.55mm (both inclusive)</td>
<td>220</td>
</tr>
<tr>
<td>0.63 to 1.0mm (both inclusive)</td>
<td>275</td>
</tr>
<tr>
<td>Above 1.0 mm</td>
<td>350</td>
</tr>
</tbody>
</table>

**Note:** The recommended thickness for roofing application in IS is 0.63 mm and corresponding recommended grade of coating is minimum 275 gm/ m2.

10.29.1 Plain sheets shall be reasonably flat and free from twist. Corrugated sheets shall be free from twist or buckle and shall have uniform corrugation, true in depth and pitch, and parallel to the sides of the sheets. The galvanized coating shall be clean, even and free from ungalvanised spots and other defects. The tolerance on weight of an individual sheet shall be +/- 10% and tolerance on a bundle of sheet shall be +/- 5%.

**10.30 Barbed Wire**

Galvanised steel barbed wire for fencing shall confirm to IS 278-2001, Specification for galvanized steel
10.30.1 Barbed wire shall be stretched and fixed in specified number of rows and diagonals. The diagonals wires will be interwoven with horizontal wires by fixing the old rows of wires, then the diagonal cross wires and lastly the even rows of wires. The barbed wires shall be held to the RCC posts by means of GI staples fixed to wooden plugs or GI binding wire tied to 6 mm bar nibs fixed while casting the posts. The barbed wire shall be fastended to the ballies/timber posts by means of GI staples, driven into the post. Turn buckles and straining bolts shall be used at the end posts where indicated.

10.31 Mild Steel Wire

Mild steel wire for fencing, mattresses shaped nets, etc. shall be galvanized and shall conform to IS 280-2006, specification for mild steel wire for general engineering purposes. All finished steel wire shall be well and cleanly drawn. Wires shall be sound and free from splits, surfaces flaw, rough jagged and imperfect edges and other harmful surface defects. Zinc coating shall be smooth, even and bright. Fixing arrangements shall be as directed.

10.33 Welded Steel Wire Fabric.

Wire fabric for general use such as fencing, windows grills etc. shall confirm to IS 4948-2002, specification for welded steel wire fabric for general use. The longitudinal and transverse wire shall be securely connected at every intersection by process of welding. Wire fabric shall be rust proof and free from injurious defects. The mesh size and the size of wires shall be as indicated. Steel wire fabric in each panel shall be in one whole piece. Wire fabric shall be fixed with wooden beads or MS flats as indicated.

10.33.1 The welded steel wire fabric in fencing shall be stretched and fixed to the posts by means of GI staple fixed to wooden plugs or GI binding wire tied to 6 mm bar nibs, fixed while casting the posts 25 cm apart or as indicated.

10.35 Fan Clamps

Circular cast iron box for ceiling fan clamps shall be fixed during the laying of RCC slabs. The sizes of the box shall be 10 cm overall dia, 75 mm height, with rim thickness of 5 mm. Bottom and top lid shall be 1.5 mm thick mild steel sheet with its top surface hacked for proper bonding with the concrete. Lid shall be screwed to the box. Fan clamps shall be made of 12 mm dia mild steel bar bent to shape with its end bent as directed.

10.36. ALUMINIUM WORK

Aluminium Sections:

Aluminium sections used for fixed/openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in-Charge for technical, structural, functional and visual considerations. Chemical and mechanical properties of sections shall comply with requirements given in IS 733-1983, Specification for wrought aluminium and aluminium alloys bars, rods and sections, IS 737-1986, Specification for wrought aluminium and aluminium alloys sheet and strip for general engineering purposes and IS 1285-2002, Specification for wrought aluminium and aluminium alloys extruded round tube and hollow sections for general engineering purposes. The stainless steel screws shall be of grade AISI 304. Joining of sections, providing fittings, lugs, method of fixing etc shall be as per IS 1948 - 1961. The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows.

Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings.
The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Consultant and Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Consultant and Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval of Consultant and Engineer-in-Charge and nothing extra shall be paid on this account.

Anodising:

Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensures uniform coating in uniform colour and shades. The extrusions are anodized up to 30 micron in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard IS 1868 and Testing of anodizing coating shall be in accordance with IS 5523-1983.

Powder Coating

Material:

The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer-in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

Pre-treatment:

Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coating supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer-in-Charge. The metal surface after the conversion coating pretreatment and prior to the application of the coating shall be free from dust or powdery deposits.

Process:

The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

Thickness:

The thickness of the finished polyester measured by micron meter shall not be less than 55 micron and not more than 120 micron at any point.

ALUMINIUM FRAME WORK:

Frame Work:

First of all the shop drawings for each type particulars shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, windows, ventilators etc. The shop
Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered joints shall be corner crimped or fixed with self tapping stainless steel screws using extruded aluminium cleats of required length and profile. All aluminium work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

**Fixing of Frames:**

The Frame work of particulars shall be fixed to Ceiling or wall with supporting materials and devices for rigidity as approved by the Consultant and the Engineer – in – Charge. The main and the Cross members shall be jointed with angle bracket as indicated in the fabrication Drawing, if not indicated it shall be 15mmx15mmx1.5mm, fixed with suitable bolts, nuts and washers etc., The panel size shall be as per the approved drawings. Fixing of Glazing Clips shall be done carefully and no hammer markings shall be seen on the same and only wooden mallet shall be used.

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/fasteners/screws shall be drilled with an appropriate electric drill. Windows/doors/ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Engineer-in-Charge in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap beadings and EPDM gasket shall be fixed as per the detail shown in the shop drawings.

Where aluminium comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

Before fabrication the size of the windows and opening shall be acertained.

**Performance Requirements for the Finish**

**(i) Surface appearance:**

The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

**(ii) Adhesion:** SIGNATURE OF TENDERER WITH SEAL

When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

**Protection of Powder Coated / Anodizing Finish :**
It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

**Measurement:**

All the aluminium sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

**Rate:**

The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

---

**SECTION-11**

**ROOF COVERING**

11. **INDIAN STANDARDS**

<table>
<thead>
<tr>
<th>I.S.</th>
<th>SUBJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 513</td>
<td>Cold Rolled, steel</td>
</tr>
<tr>
<td>ASTM A792M,ASTM A446 Grade ‘E’</td>
<td>Hot-dip Al-Zinc coated steel</td>
</tr>
<tr>
<td>AS 1562</td>
<td>Design and installation of metal roofing</td>
</tr>
</tbody>
</table>
A. GALVALUME STEEL SHEET

11.1 SCOPE

This section covers the general requirements for roofing and side cladding system. The work all includes the construction Management, supply, and, installation. of the roofing/cladding system as described in the schedule and shown on the drawings, including all fixings, flashings, finishing, capping, gutters, down pipes etc.

11.2 General

The contractor shall supply and install roof and side cladding, accessories, gutters etc. as specified and as approved by the EIC with uniform and, consistent product quality. All materials shall be delivered to, site with manufacturer's name or trademark, grade of coating, length, thickness and item identification. The material may be marked with a standard mark where applicable.

11.2.1 Materials

The sheets, and accessories shall be of Cold rolled steel with 550 MPa yield stress (conforming to relevant ASTM) including the sheets (55% aluminum ,43.5% zinc , 1.5% silicon) shall have metallurgical coating (AZ-150) of aluminium and zinc alloy (both side inclusive) 150gsm conforming to ASTM A 792 M.

Minimum thickness shall be:
Total Coated Thickness (mm) : 0.60

11.2.2 External Sheeting: Profile:

Profile of sheet should match with PEB roofing/cladding of the main building.

11.2.3 Organic Coating:

Silicon modified polyester coating (Exterior side/top side) : 20 microns

Epoxy primer (on both sides) : 5 to 7 microns

Standard Backing coat : 5 to 7 microns

11.2.4 Installation

Fixing system shall be as per manufacturers instructions and shall be safe against effects of wind velocity.

11.2.4.1 Sub-Girts: (If and where required)

Material:
"Z" shaped 50 x 50 x 50 mm x 1.6 mm galvanized Steel (175 gms / sqm zinc coating mass)

Fixing :

Fixed to purlins through 30w x 30bx 33h mm spacer blocks (in suitable non-flammable material) with galvanized hex head self-drilling fasteners at maximum 500 mm centers.

11.2.4.2 Single skin side cladding

Same as external sheeting of single skin roof cladding, clause 11.2.2

11.3 Accessories

11.3.1 Cappings, Flashings, Trims and Gutters:
Profile:

Factory formed to required shape and profile based on shop drawings in 2.5 m lengths. All transverse cappings to be notched to match profile of external / internal sheet except where metal capped neoprene fillers are used.

All exposed flashing edges must have a 12 mm hem and a 45° drip where shown on the drawings. All closure flashings shall be hemmed to ensure that no cut edge is exposed to view or to the weather.

Fixing:

Capping etc. shall be screwed to external / internal sheeting at crests with colour matched nylon head self drilling stitching fasteners at max. 500 mm centers along the length of the capping, flashing. All fasteners must be installed at 90°to the material being fastened. If this is not done, the screw must be withdrawn and the hole closed with an oversize screw and EPDM washer. All longitudinal joints in cappings flashings and gutters shall be overlapped a minimum of 50 mm and sealed with a continuous run of sealant.

11.3.2 Fixing Accessories

11.3.2.1 External fasteners

Fasteners for external sheeting (roof and wall) and self drilling stitching fasteners for sheet side laps, cappings and flashings shall be mechanically galvanized carbon steel self drilling self tapping fasteners with integral nylon heads (colour matched to external sheeting) with EPDM seals. Nylon caps on steel heads are not acceptable.

11.3.2.2 Internal fasteners:

Fasteners for fixing internal sheeting and sub-grits shall be zinc coated carbon steel self drilling self tapping fasteners with integral hexagonal" washer heads.

11.3.2.3 Sealants:

Penetrations and end laps in sheeting shall be sealed with a non-hardening butyl silicon sealant or other approved sealant.

11.3.2.4 Profiled neoprene fillers:

Profiled neoprene fillers shall be provided wherever required to close the voids between capping and the troughs of the external sheeting so as to provide a weather tight exterior. These shall be out of neoprene die cut in profile to match external sheeting. All exposed neoprene fillers shall be covered with notched metal closures to protect from UV.

11.4 PERFORMANCE REQUIREMENTS

11.4.1 Finish-External sheets

External sheets shall be coil coated (preprinted) with a Silicon modified polyester organic colour of owner's choice as per manufacturer's standard colour chart which shall be furnished for selection.

SIGNATURE OF TENDERER WITH SEAL

The coating shall have been tested in accordance with ASTM or equivalent standards

External Roof sheeting shall be capable of withstanding wind uplift and point loads as per IS Codes.

11.4.2 Testing and Acceptance Criteria

Materials:

Prior to delivery, manufacturers test certificates shall be supplied for all materials certifying grade and conformity with applicable standards. At Architect's discretion on number and frequency, random samples
11.4.3 Guarantee

The Contractor shall be required to furnish a guarantee for the exterior roof and side cladding for 15 years for silicon modified polyester.

11.5 OTHERS

11.5.1 Material Sources:

The organic coated steel must be sourced from a reputed manufacturer who has adequate experience in coating the given specification material. The coated coil supplier should be a licensed manufacturer and organic coil-coater of galvanized or Galvalume steel. Performance guarantee certificates for the coated coil should be given by the principals.

11.5.2 Measurements

Sheeting and accessories shall be supplied in sizes and quantity as required including portion covered in ridge as per shop drawings. Measurements for payment shall be over laid area of external sheeting from edge to edge for roof and side to side for side cladding. No deduction shall be made for cutouts less than 1 sqm in roofing or cladding or for diagonal cuttings. The side and end overlap shall be minimum 150mm as per manufacturers specification. However, Contractor may provide longer overlap to avoid cutting or any other reason, but no extra payment shall be made separately. Overlap of sheeting shall not be measured and paid separately. The contractor must include for all of the above in the rates quoted by them for the roof sheeting.

11.6 FIXING PROCEDURE OF SINGLE SKIN ROOF AND SIDE CLADDING

11.6.1.1 The external sheets shall be laid over the purlins and fixed to the purlin with self-drilling fasteners.

11.6.1.2 Side-laps in external sheeting shall be mechanically held in place and all fasteners except side-lap fasteners fixed first. Side-laps shall be fastened last. All sheets shall be laid taking due care of local wind direction and recommended direction of lying so as to have all side-laps face away from prevailing weather.

11.6.1.3 All fixings are to be made with self drilling self tapping fasteners. Where purlin or support thickness exceeds fastener manufacturer’s recommendation for self drill fixing & pilot holes shall be drilled of a size smaller than thread diameter of fasteners. All fasteners must be installed at 90° to the material being fastened. If this is not done, the screw must be withdrawn and--the hole closed with an oversize screw and EPDM washer.

11.6.1.4 Cappings, flashings and gutters shall be fixed over the external and internal sheeting. All longitudinal joints in cappings and flashings shall be overlapped a minimum of 50 mm and sealed with a continuous run of sealant. Cappings shall have ends turned down and notched where required so as to seat in the pans of the external sheeting except where metal capped neoprene fillers are provided wherever shown on the drawings.

11.7 STORAGE AND HANDLING OF SHEETING

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

11.7.1 Care and storage prior to Installation

Roof and wall sheeting should be delivered to the site in strapped bundles. If not required for immediate use, sheets or bundles would be neatly stacked clear of the ground and if left in the open would be protected from rain and moisture with waterproof covers. On no account should sheeting in any surface finish be allowed to get wet while in still bundles or rested in stacks. If packs become wet, the sheets should be separated without delay and the surface moisture removed with a clean cloth.

11.7.2 Handling on Site

For long length sheets spreader bars and fabric slings should be used for lifting by crane. Without-mechanic
Handling facilities, sheets could be unloaded by hand and passed up to the roof one at a time. To preserve the surface finish, and for personal safety, sheets should be handled wearing clean dry gloves. Sheets should not be slid over rough surfaces or over each other and no tools etc. should be dragged over sheets.

11.7.3 Walking on Roof Sheeting

Contractor shall ensure that when walking along the length of roof sheeting, the workers walk in the trays of the profiles. When walking across the length of roof sheeting, workers should walk on the ribs of the sheeting and close to the roofing supports. Workers should wear soft soled shoes but not the ribbed type that pick up and hold small stones etc.

11.7.4 Cleaning Up

Nominal installation procedures for roofing and flashing using self drilling screws; drills, hack-saws or files with usually deposit metallic particles on or near the roof sheeting and roof area. These metallic particles and all over debris including blind rivet shanks, nails, screws, nuts, cuttings, swarf etc. should be removed certainly at the end of each days work and particularly on completion of the roof installation.

11.8 TEMPORARY CONSTRUCTION OPENINGS

Temporary construction openings may be required to be provided in wall claddings. The Contractor shall provide such construction openings at locations directed by the Consultant/EIC and shall close up and make good such openings when directed. No extra payment shall be made for providing such opening.

B. POLYCARBONATE SHEET

UV coated bronze / clear colour Lexan Polycarbonate sheet of GE plastics or approved equivalent with embossed finish for light diffusion shall be used for roof and wall cladding. To allow for expansion and contraction suitable extruded aluminium profile shall be used for fixing polycarbonate sheet. Polycarbonate sheet shall have specific gravity of 1.2 grams / CC and light transmission ranges from 30% to 70%. Flame retarding property of sheet should comply with class I of BS 476. The fixing of sheet shall be done as per specification and instruction of manufacturer and as directed by the EIC.

11.9 Integral Cement based Water Proofing treatment including preparation of. Surface as required for treating roofs, balconies, Terraces etc with Brick Bat Coba.

11.9.1 Preliminaries to be attended

(i) Before taking up the waterproofing work the construction of parapet walls etc, including finishing should be completed in all respects.
(ii) Similarly, the ancillary items like haunches, khurras, grooves to tack the fiber cloth layer, where ever applicable fixing up of all down-take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

SIGNATURE OF TENDERER WITH SEAL  EMPLOYER

11.9.2 Preparing the Surface

It would be advantageous to roughen the surface by scraping the surface when the slab is being cast, however the surface need not be hacked. In case the slab is already cast and surface fairly finished, the same shall be cleaned neatly of all mortar droppings, loose materials etc.

11.9.3 Blending Cement Water with water Proofing Compound

(i) Whenever the water proofing compound is to be used, it is advantageous to blend the same with cement if the water proofing compound is in powder form and if the same is in liquid form the required quantity of water blended with water proofing compound alone should be used for preparing slurry / mortar.
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex)

VOLUME -II. TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

(ii) The water proofing compound to be used shall conform to IS:2645 and be of reputed brand with a clear IS1 marked on the container which should be in the form of sealed tins or closed packets. (iii) The correct quantity of water proofing compound to be used per 50 Kg grey cement shall be as prescribed by the manufacturer on the tins/packets literature. However, not more than 3% of water proofing compound shall be used per 50 Kg of grey cement.

(iv) Blended cement with water proofing compound or water mixed with liquid water proofing compound shall be used to prepare slurry/mortar.

The water proofing compound shall be used / mixed for preparation of slurry, mortar bedding layer, top layer or wherever cement finishing is required.

11.9.4 Preparing of Slurry

(i) The quantity of water required to prepare the slurry with 2.75 Kg of cement to be painted/applied over an area of 1 sqm shall be calculated exactly as described below.

This can be done only by trial and error method by preparing few samples with prescribed quantity of cement and applying over few patches each of say 1/2 sqm area and thus the required quantity of water per sqm area can be decided say ‘x’ litres per sqm.

(ii) Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 Kg blended cement/sqm + x litres of water per sqm area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within 1/2 an hour of preparation.

11.9.5 Application of Slurry under Base coat

(i) The slurry prepared as explained above shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces and joints of pipes in masonry/concrete.

(ii) The application of the slurry should continue up to a height of 300 mm over the parapet wall and also to the groove. The slurry should also be applied up to a height of 150 mm over pipe projection etc.

11.9.6 Laying Base coat 25mm thick

Immediately after the application of slurry and when the application is still green, 25mm thick average cement plaster as base coat with cement mortar 1:4 (1 blended cement: 4 sand) shall be evenly applied over the concrete surface taking particular care to see that all corners and joints are properly packed and the application of the base coat shall be continued up to a height of 300 mm over the parapet wall.

11.9.7 Placing of Brick bat

Brick bats of size 40 to 75mm thick shall be placed over the screed bed by hand packing having minimum 15mm thick mortar below the brick bats and suitable gaps in between. Only fully burnt bricks shall be used and the brick bats shall be well soaked before laying. Application of another layer of slurry after curing of the
above surface for a minimum period of 24 hours as per the specification mentioned herein above. Then filling the gaps between the brick bats with Cement mortar 1:4.

11.9.10 Laying Finishing Layer (Protective Coat)

(i) Immediately on applying the cement mortar as above and the surface is green, a 20 mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended grey cement: 4 sand) over the entire surface including the haunches/ gola and the small portion on the parapet wall. The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove.

(ii) The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry and finished smooth with wooden / steel hand float. The finished surface shall be allowed to dry for a while till a string mark can easily be made on the surface, when 300mm x 300 mm square marks shall be made over the entire surface.

The water proofing treatment shall be covered upto minimum 30cm on parapet wall, and wherever parapet wall exists the wall plaster shall project over the treatment.

11.9.11 Curing and Testing the Treatment

The entire surface thus treated shall be flooded with water by making bunds with weak cement mortar, water shall be made to remain on the roof slab for a minimum period of two weeks during which it can be observed if there are any leakage or not.

Brick bat coba shall be provided as specified, however recommended average thickness is 120mm and minimum 65 mm.

The measurement shall be taken flat between the parapets or end to end where parapet wall does not exists. The covering of Parapet wall shall not be measured and paid.

SECTION-12

FALSE CEILINGS, PARTITIONS AND LININGS

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
12.1 Indian Standards The following IS with latest revision apply to this section.

<table>
<thead>
<tr>
<th>I.S. No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>373-1975</td>
<td>Specification for plywood for general purposes (second revision) (with Amdt No. 1 to 3).</td>
</tr>
<tr>
<td>451-1972</td>
<td>Technical supply conditions for wood screws (second revision)</td>
</tr>
<tr>
<td>723-1972</td>
<td>Specification for steel countersunk head wire nails (first revision)</td>
</tr>
<tr>
<td>749-1978</td>
<td>Specification for handloom cotton dungi cloth, grey (first revision)</td>
</tr>
<tr>
<td>'848-1974</td>
<td>Synthetic resin adhesive for plywood</td>
</tr>
<tr>
<td>1328-1982</td>
<td>Specification for veneered decorative plywood (second revision)</td>
</tr>
<tr>
<td>1658-1977</td>
<td>Specification for fibre hard-boards (second revision)</td>
</tr>
<tr>
<td>1659-1979</td>
<td>Specification for block boards (second revision)</td>
</tr>
<tr>
<td>2046-1969</td>
<td>Specification for decorative thermosetting synthetic resin bonded laminated sheets (first revision)</td>
</tr>
<tr>
<td>2098-1964</td>
<td>Specification for asbestos cement building boards.</td>
</tr>
<tr>
<td>3087-1985</td>
<td>Specification for ‘wood particle boards (medium density) for general purposes (first revision)</td>
</tr>
<tr>
<td>3129-1965</td>
<td>Specification for particle board for insulation purposes</td>
</tr>
<tr>
<td>3348-1965</td>
<td>Specification for fibre insulation boards</td>
</tr>
<tr>
<td>8183-1976</td>
<td>Specification for bonded mineral wool</td>
</tr>
<tr>
<td>12406-1988</td>
<td>Medium density fibre board for general purposes.</td>
</tr>
<tr>
<td>2095-1982</td>
<td>Specifications for Gypsum plaster boards.</td>
</tr>
</tbody>
</table>

12.2 FITTINGS AND ACCESS PANELS

Lighting fittings, access panels and similar components are incorporated as part of the design requirements, consideration must be given to maintaining the integrity of the ceiling when fire resistance and sound insulation are also important factors.

12.5 Fibre Insulation Boards:

Fibre insulation boards shall conform to the requirements of IS 3348. Specification for fibre insulation boards. The boards shall be ordinarily type except where flame retardant type is indicated. The mean density of the boards shall not exceed 0.4 gm / cu.cm. Flame retardant boards may be treated on one face or both the faces, as indicated.

12.5.1 In the case of flame retardant boards on one face only, the face which is treated shall be clearly marked.

12.5.2 Tolerance: Permissible tolerance on the thickness of the fibre insulation board shall be as under:

12 mm thick boards : +/- 0.75 mm
126 Particle Boards for Insulation Purposes:

Particle boards for insulation purposes shall conform to the requirements of IS 3129-1985, Specification for particle board for insulation purposes. Boards shall have either flame retardant chemical mixed during manufacture or shall be impregnated with a solution of flame retardant chemical. The density of the board shall not exceed 0.4 gm/cm³ and shall not vary from board to board by more than +/- 10 percent.

12.6.1 The permissible tolerances on the nominal thickness of finished boards shall be as follows: -.

- For boards upto 25 mm thick: ± 0.8 mm
- For boards above 25 mm thick: ± 1 mm

127 Medium Density Fibre Board:

Medium density fibre board shall conform to the requirement of IS 12406-1988. Grade of the board shall be indicated.

Designate

- Exterior grade phenol formal (EGSB)
- Interior grade (IGSB)

Thickness of the board shall be indicated.

128 Decorative Laminates:

Decorative Laminates shall be type 1 having only one side bearing the decorative surface and the other side being roughened or given appropriate treatment to promote adhesion to the base and shall conform to the requirements of IS 2046-1995, Specification for decorative thermosetting synthetic resin bonded laminated sheets. IS 2046 does not cover 1 mm thick decorative laminates which when specified, shall be of approved make.

12.8.1.1 The type of surface finish colour and pattern shall be as directed. The sheets shall be reasonably free from local deformation. Since sheets may vary slightly in colour and appearance, the sheets for anyone scheme shall be matched.

12.8.2 Tolerance:

Tolerance on thickness of sheets shall not exceed +/- 0.25 mm.

12.8.1.3 Sheets shall not split or crack when sawn, milled, drilled and tapped.

12.11 Plywood:

Plywood shall conform to requirements of IS 373-1975, Specification for plywood for general purposes. Plywood shall be of grades BWP (boiling water proof) or BWR (boiling water resistant), as indicated. The quality requirement of each face of the plywood as given in Table 1 of the IS, shall not be inferior than type B. Along with the thickness of plywood, the number of plies shall also be indicated.

12.11.1 Plywood boards shall be uniform thickness and free from warp and cracks. The faces of plywood boards shall be reasonably smooth with face veneers of uniform thickness. The edges of the boards shall be trimmed square.

12.11.2 Tolerance:

Permissible tolerance on the thickness of plywood boards shall be as under:

- For boards upto 5 mm thick: ±10 percent
12.12 Decorative Plywood:

Decorative plywood shall be of Type 1 quality conforming to IS 1328-1996, Specification for veneered decorative plywood. Decorative plywood shall have decorative veneers of the specified species of timber and on one or both the faces, as indicated.

12.12.1.1 The adhesive for bonding of veneers shall be synthetic resin adhesive, confirming to IS 848-1974.

12.12.1.2 Tolerance: Permissible tolerances on the thickness shall be as under:

- Positive: 10 percent of nominal thickness.
- Negative: 5 percent of nominal thickness.

12.13 Block Boards:

Block boards shall conform to the requirements of IS 1959-2004, Specification for block boards. Block boards shall be of grade 1 quality, exterior grade or grade 2 quality, interior grade and of decorative or commercial type as indicated. In case of decorative type it shall be indicated if one or both the faces shall have decorative face veneer. Strips of wood in the core may be laid separately or glued or otherwise jointed.

12.13.1 Block Boards shall be flat and square. Both faces of block board shall be sanded ‘to a smooth even surface. Block boards shall be uniform in thickness with in the tolerance specified.

12.13.2 Tolerance permissible on the thickness of block boards shall be +/- 5 percent for boards up to 25 mm thickness and +/- 2.5 percent for boards above 25 mm thickness.

12.14 Particle Boards

Particle Boards shall conform to the requirements of IS 3087-2005, Specification for wood particle boards (medium density) for general proposes. Adhesive used for bonding purpose shall phenol formaldehyde as indicated.

12.14.1 Particle boards may be either Flat Pressed single layer type or Flat pressed there layer type, unless a particular type has been indicated. In case of three layer particle boards the construction shall be well balanced about the central plane. In the case of single layer particle board the particles shall be uniformly distributed.

12.14.2.1 Particle boards shall be of uniform thickness and uniform density throughout the board. Both faces of particle boards shall have sanded smooth finish.

12.14.3 Density

Mean density of the board shall be between 500 to 900 Kg / cum. The density shall not vary from one board to another by more than 10 Percent of the mean density.

12.14.4 Particle boards shall not crack or split when drilled, sawed or nailed perpendicular to the surface.

12.14.5 Tolerance

Tolerance permissible on the thickness of particle boards shall be ±5 Percent boards up to 25 mm thick and ±2.5 Percent for boards above 25 mm thick.

12.15 Veneered Particle Boards
Veneered particle boards shall conform to the requirements of IS:3097-1980, Specification for veneered particle boards. The boards shall be of interior or exterior grade with solid core, and shall be general purpose type or decorative type, as indicated. In case of decorative type it shall be indicated if one or both faces shall have decorative face veneer. Face veneers of commercial type veneered boards shall be not inferior then exterior grade phenol formaldehyde.

12.16 Finish & Tolerance

Finished and tolerance permissible on the thickness of veneered particle boards shall be same as specified under 'Block boards'.

12.17 Nails & Screws

Nails shall conform to IS 723-1972, specification for steel countersunk head wire nails. The nails shall be diamond pointed. Screw shall conform to IS 451-1999. Technical supply conditions for wood screws. Special nails recommended by the manufacturer, if any, shall be invariably used.

12.18 MATERIAL

The type of boarding etc. in ceiling and lining, their thickness/density and finish shall be as indicated.

12.19 Fixing Generally

12.19.1 When handling, boards and sheets shall be carried on edge and not flat to percent buckling and cracking.

12.19.2 Before fixing, the board shall be conditioned to the humidity of the atmosphere by stacking then loosely on edge for a period of 24 hrs so that air can have free access to both sides of each sheets during the period. Hardboards shall be conditioned as specified under 'Fixing Hardboards'.

12.19.3 Before fixing the boards, sheeting tiles, etc. to the Framework, the framework shall be checked with regard to the level, position and vertically of its out side surface and for proper fixture and joints.

12.19.4 Boards, sheeting, tiles etc. shall be checked for corrected sizes, squareness of adjacent sides and laying patterns.

12.19.5 Boards shall be cut to the required size and to conform to the pattern of panels as directed. Each panel shall be in one whole piece. The board should be sawn with the face-side up and a fine and even edge obtained. The joints in the boards shall be with the square or slightly rounded edges as directed. The edges shall be lightly sandpapered to make them smooth.

12.19.6 Fixing

Unless otherwise directed, boards shall be fixed with length parallel to all joints, centered over farming members. Where the joints are to be covered, the boards shall be closed butt jointed or spaced 3 to 6 mm apart as per manufacture’s instructions or as directed. Where joints are to be left exposed, the boards shall be butt jointed with a minimum clearance of 3 mm or as directed. The boards shall be supported and held tight to the background with timber pieces, these being marked outwards as the fixing proceeds. The boards are first fixed to the intermediate framing member proceeding from the center of the boards outwards, the edges being fixed last.

12.19.7 Where boards are fixed with nails, they shall be countersunk into the boards with suitable punch. Care shall be taken in driving the nails that the boards/sheets are not marked by hammer blows.

12.19.8 The screws shall be rustless and oiled before fixing.

12.19.9 Finishing

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
The exposed side of the board fixed in ceiling shall be truly level and plane except in the case of sloped ceiling and truly vertical when fixed in wall lining without any local bulges or sags. The joints shall be truly parallel and/or perpendicular to the walls. The width of joints shall be uniform.

Care shall be taken to ensure that the boards are not made dirty and uniformity of the colour or the boards is not spoiled during the fixing operations. Ceiling boards and wall linings, when fixed, shall present a neat and uniform appearance.

12.20 DELETED

12.21 Fixing of Plywood, Block board, Particle Board and Veneered particle Board

12.21.1 Decorative veneers shall be matched or mismatched to achieve a decorative effect in colour, figure and grain. Where directed decorative veneers boards shall be matched to particular design, for example quartered, centered, diamond or V matched or shall be arranged to from a group to give an overall general effect. The pattern and figure matching shall be decided, put on paper and boards preferably numbered for their positions. Any board so required shall be cut to the required plan.

12.21.2 The boards shall be carefully lifted and fixed to the frame-work with wood screws. All the edges shall be fixed to the frame members by screws spaced 7.5 cm center for 4 mm to 6 mm thick plywood, for thicker boards, the center-to-center spacing of screws maybe at about 15 times the thickness. The screws shall have a clearance of 10 mm from the edge line. At the line of intermediate support, the screws shall be countersunk. The screws shall be fixed starting from one corner and, extending to both sides to fix the board flat and level. The length of the screws shall be as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>For boards up to 7 mm thick</td>
</tr>
<tr>
<td>b)</td>
<td>For boards above 7 mm up to 12 mm thick</td>
</tr>
<tr>
<td>c)</td>
<td>For boards above 12 mm thick</td>
</tr>
</tbody>
</table>

12.21 .3 The joints, if left open, shall be filled with painters putty and brought to level or may be cut to "V" shape. They may also be left open" beveled or parallel grooved using plane and chisel or grooving cutter. The boards may also be pre-cut and edges rounded before fixing. In the case of decorative boards, the joints may be coloured to match the general colour and pattern of the ceiling boards. Alternatively, the open joints shall be covered by a beading or strips as indicated.

12.22 Galvanised Steel framework for false ceiling work

12.22.1 (a) Materials

i) Galvanised steel sections incorporated in framework shall conform relevant IS codes.

ii) The grid shall consist of galvanized steel main Tees of size 33 (H) mm x 24mm.

(b) Workmanship

i) Grid framework shall be suspended/fixed from RCC/Structural steel roof using 3mm dia GI rod, 6mm nylon rawl plug and 6mm J bolt at every 1200mm intervals with necessary bolts, nuts and washers all as per manufacturer's instruction.

ii) The main Tees shall be provided at every 1.2M center to center, stitched cross Tee at 0.6m center to center fixed with suitable GI bolts, nuts and washers all as per manufacturer’s instruction.

iii) The grid (main / cross tee section) shall be supported at ends all along the wall with GI angle as per consultant.

iv) GI coating shall conform to IS277 class coating for respective thickness and testing shall be all as directed.

v) PVC protected sheeting shall be used to avoid scratches, damage to the framework while fixing to ceiling.
12.23 Calcium silicate false ceiling

Metal framed suspended ceiling comprises of G.I perimeter channel having two unequal flanges of 20 and 30 mm and web of 27 mm is fixed to surrounding walls /Partition using nylon sleeves and screws at 450 mm centres. Then intermediate channel having two equal flanges of 15 mm each and a web of 45 mm is suspended from the soffit at 1220 mm centre with ceiling angle of width 25 mm x 10 mm x 0.55 mm thick, fixed to soffit with G.I cleat and steel expansion fasteners. Ceiling section of 0.55 mm thickness having knurled web of 50.5 mm and flanges of 26 mm each with lips of 10.5 mm are then fixed to the intermediate channel with connecting clips across to the Intermediate channel, at 457 mm centers. 8 mm thick square/tapered edge Calcium Silicate Boards are then screw fixed across the ceiling sections with 25 mm long self drilling & tapping screws having Phillips head with under head cutter, at 200 mm c/c through the Calcium Silicate Board fillets.

Openings for light fittings, access panels and A/C grills

Openings for the above to be made by using perimeter channel around the opening and suitably suspending this area by using extra sections to maintain the integrity of the ceiling

Access Panel :

Access panels are provided in suspended ceilings for repairs/maintenance purpose of the air condition ducts etc. These to be made by providing additional perimeter channel around the opening and other sections to maintain the integrity of the ceiling. Calcium Silicate Board is then fixed to the frame work with self drilling screws.

Frame Work:

First of all ceiling level is marked on to the wall/Partition as per the drawing, leaving a scope for board thickness. G.I. perimeter channel is fixed to the perimeter of the wall/Partition with nylon sleeves and wood screws (38 mm long) at 457 mm centres, at the above level. Intermediate channel is suspended from the soffit at 1220 mm c/c with the help of rawl plug, sofit cleat and the ceiling angle, in one direction. Ceiling sections are attached to the intermediate channel, across to it, by connecting clips at 457 mm centres. The length of ceiling sections or intermediate channels, can be increased by providing an overlap of 6” and are screw fixed at four places.

Board Fixing

Calcium Silicate tapered edge boards of size, 6’ x 4’ are fixed to the under side of ceiling sections by 25 mm long self drilling & tapping screws having Phillips head with under head cutter at 200 mm c/c. The screws should be 15 mm away from the edges and 40 mm from the corners. The square edges of the boards are made tapered (40 x 1.5 mm) or chamfered by 4 x 3 mm at site before fixing. The joints between boards are staggered in brick work style to make the ceiling rigid and properly aligned to the required level.

Jointing & Finishing :

Calcium Silicate Board joints are finished with specially formulated jointing compound and 48 mm wide, fiber tape to get seamless finish. Cement primer (Oil based) to be provided on entire surface before putty / painting.

12.24 Rock Wool Insulation

Density - 48 kgs/cum and 96 Kg/Cum

Thickness – 50 mm

Thermal conductivity - 0.038 W/mk

Fixing method : Fixing with MS hollow tubes, channels , Weld mesh

SECTION -13
13.1 Indian Standards

The following IS with latest revision apply to this section:

<table>
<thead>
<tr>
<th>I.S. No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>653-1980</td>
<td>Specification for sheet linoleum (second revision)</td>
</tr>
<tr>
<td>777-1970</td>
<td>Specification for glazed earthenware tiles (first revision with Amdt.No.1)</td>
</tr>
<tr>
<td>809-1970</td>
<td>Specification for rubber flooring materials for general purposes (first revision)</td>
</tr>
<tr>
<td>1195-1978</td>
<td>Specification for bitumen mastic for flooring (second revision)</td>
</tr>
<tr>
<td>1237-1980</td>
<td>Specification for cement concrete flooring tiles (first revision)</td>
</tr>
<tr>
<td>1580-1969</td>
<td>Specification for bituminous compound for waterproofing and caulking purposes (first revision)</td>
</tr>
<tr>
<td>2114-1984</td>
<td>Code of practice for laying in situ terrazzo floor (first revision)</td>
</tr>
<tr>
<td>2508-1984</td>
<td>Specification for low density polythene films (second revision)</td>
</tr>
<tr>
<td>3461-1980</td>
<td>Specification for PVC asbestos floor tiles</td>
</tr>
<tr>
<td>3462-1986</td>
<td>Specification for flexible PVC flooring (first revision)</td>
</tr>
<tr>
<td>4457-1982</td>
<td>Specification for ceramic unglazed vitreous acid resistant tiles (first revision)</td>
</tr>
<tr>
<td>8042-1978</td>
<td>Specification for white Portland cement (first revision)</td>
</tr>
</tbody>
</table>

13.2 Cement

Cement shall be ordinary Portland Cement 43 grade conforming to IS 8112.

13.2.1 White cement: White cement shall conform IS 8042 specification for white Portland cement.

13.3 Aggregates

Coarse and fine aggregates for cement concrete and granolithic concrete shall conform to IS 383.

13.3.1 Aggregates for granolithic concrete shall consist of crushed granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 per cent. The grading of aggregates shall be as given below:

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage by Coarse Aggregate</th>
<th>Weight passing IS Fine Aggregate Zone 1</th>
<th>Sieve Zone 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5</td>
<td>90 to 100</td>
<td>90 to 100</td>
<td>90 to 100</td>
</tr>
<tr>
<td>10</td>
<td>40 to 85</td>
<td>90 to 100</td>
<td>90 to 100</td>
</tr>
<tr>
<td>4.75</td>
<td>0 to 10</td>
<td>60 to 95</td>
<td>75 to 100</td>
</tr>
<tr>
<td>2.36</td>
<td>30 to 70</td>
<td>30 to 70</td>
<td>55 to 90</td>
</tr>
<tr>
<td>1.18</td>
<td>30 to 70</td>
<td>30 to 70</td>
<td>55 to 90</td>
</tr>
<tr>
<td>600 micron</td>
<td>15 to 34</td>
<td>35 to 59</td>
<td></td>
</tr>
<tr>
<td>300 micron</td>
<td>5 to 20</td>
<td>8 to 30</td>
<td></td>
</tr>
<tr>
<td>150 micron</td>
<td>0 to 10</td>
<td>0 to 10</td>
<td></td>
</tr>
</tbody>
</table>

13.3.2 Sand for mortar for laying slab/tiles shall conform to IS 2116 as specified in Brick work.

13.4 to 13.12 DELETED

13.13 Polythene Film
Polythene film shall comply with relevant IS 2508-1984, Specification for high density polythene films. The film shall be of approved colour. The film shall be uniform in colour, texture and finish. The film shall be free from pinholes and substantially free from undispersed raw materials, streaks, particles of foreign matter and other visible defects such as holes, tears, and blisters. The edges shall be free from cracks and cuts. The laying of the film shall be done without any folding and shall have overlaps as specified.

13.14 GRANOLITHIC FLOORING:

Base Concrete:

Flooring shall be laid on base concrete or suspended slab where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah courtyard kitchens & baths shall have slope ranging from 1: 48 to 1: 60 depending upon location and as decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1: 30 or as decided by the Engineer-in-Charge to drain off washing water. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it.

If the base is of lean cement concrete, the flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

If the Granolithic flooring is to be laid directly on the RCC suspended slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

Thickness:
The thickness of floor shall be as specified in the description of the item.

Laying

Panels

Flooring of specified thickness shall be laid in the pattern including the border/or as given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450 mm in width and the joints in the border in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm.

Laying of flooring with strips

Normally Granolithic concrete flooring shall be laid in one operation using glass/plain asbestos/aluminium/PVC/brass strips or any other strips as required as per drawing or as specified or as per instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4 mm thick glass strips or 5 mm thick plain asbestos sheet, 2 mm PVC strips or 2 mm aluminum or brass strips, strip width shall be equal to specified floor thickness and shall be fixed with their tops at proper level, giving required slopes. Cost of providing and fixing strips as specified in item shall be included in the quoted rate. The top of Strip shall be checked to match the required level.

Concreting:

Granolithic concrete shall be placed in the panels and be leveled with the help of straight edge and trowel and beaten with a wooden ‘Thapy’ or mason’s trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge and made true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

Laying of flooring without strips:

Laying of cement concrete flooring in alternate panels may be allowed by the Engineer-in-Charge in case strips are not to be provided.
Shuttering:
The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

At any cost the forms projecting above the desired thickness shall only be permitted. The top edge of the form shall be exactly at the top level of the flooring.

Concreting:
The concreting shall be done in the manner described under sub head Laying of flooring with strips. The angle iron/flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1: 2 (1 cement: 2 sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

Finishing
The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time; till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

Fresh cement shall be mixed with water to form a thick slurry and spread at the rate of 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

The edges of sunk floors shall be finished and rounded with cement mortar 1: 2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.

The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

Curing
The curing shall be done for a minimum period of ten days or as directed by the consultant. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies shall be avoided as the colour of the flooring is likely to be bleached due to the remanents of cement dust from the bags.

Precautions
Concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

Protection Against Dampness –

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

The layer of boulder soling provided under the base concrete will generally serve the purpose of damp-proofing required for ordinary floors under normal conditions. However, in more severe conditions, where it is expected that the dampness may find its way on the top of the floor in the course of usage of floor, a more
effective damp-proof treatment shall be given underneath the floor by either of the methods given below as directed by the Engineer – in charge:

a) Laying the base concrete in two layers and painting the top of the lower layer with two coats of bitumen conforming to IS: 1580-1969* applied at the rate of 1.5 kg/m². The surface of the lower layer shall be finished smooth while laying the concrete so that bitumen can be applied uniformly. The bitumen shall be applied after the concrete has set and is sufficiently hard.

b) Sandwiching a waterproofing membrane, such as bitumen felt conforming to IS: 1322-19657 in the base concrete laid in two layers. The surface of the lower layer shall be finished smooth while laying the concrete so as to provide an even surface and thus prevent damage to the surface of waterproofing membrane.

**Effective Damp-Proof Treatment**

![Diagram of effective damp-proof treatment]

- **A Topping Laid in Single Layer**
- **B Topping Laid in Two Layer**

**Bonded Floor Finish Over Ground**

**Measurement**

Length and breadth shall be measured before laying skirting dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm.

Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

**The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same as measured together.**

**Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on RCC slab or on base concrete including roughening and cleaning...
Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunk floors.

In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

13.15 Kota Stone Flooring

13.15.1 Stone Slabs
The slab shall be of selected quality, hard, sound, dense and homogeneous in texture, free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness as indicated and they shall be of uniform colour. The slabs shall have the top (exposed) face polished before being brought to site. Before starting the work, Contractor shall get the sample of slabs approved by the Engineer-in-Charge.

13.15.2 Dressing of Slabs
Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane. For staircase treads, single piece slab to full length and width of treads shall be provided. The nosing shall be rounded off and three parallel grooves ten by ten (10mm x 10mm) immediately behind the nosing edge shall be provided to avoid skidding. Square or circular holes shall be made carefully to accommodate M.S. Baluster in position.

13.15.3 Preparation of Surface and Laying

13.15.3.1 Sub-grade concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar and the thickness as indicated.

13.15.3.2 The slabs shall be laid in the following manner:-
Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness as indicated. The slab shall be washed and cleaned before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4 kg of cement per square metre. The slab to be paved shall be lowered gently back in position bedded in level. Subsequent slabs shall be laid in the same manner and joints between adjacent slabs shall be as thin as possible and run in straight line. After each slab has been laid, surplus cement grout coming out of the joints of the slabs shall be cleaned off. The surface of the flooring as laid shall be true to levels, lines and shapes as instructed by the Engineer-in-Charge.

13.15.3.3 Slabs which are fixed in the floor adjoining the wall shall enter not less than twelve (12) mm under the plaster skirting or dado. The junction between wall plaster and the floor shall be finished neatly and without waviness.

13.15.4 Curing, Polishing and Finishing

13.15.4.1 The floor shall be kept wet for a minimum period of seven (7) days. The surface shall thereafter be ground evenly with machine fitted with fine grade blocks (No. 120). The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the first grinding described above or before handing over the floor, as ordered by the Engineer-in-Charge.

13.15.4.2 For small areas or where circumstances so require, hand polishing may be permitted in lieu of machine polishing after laying. For hand polishing the following Carborundum stones shall be used.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

with the finest grade grit blocks (No. 320) shall be carried out the day after the first grinding described above or before handing over the floor, as ordered by the Engineer-in-Charge.
1st grinding - Medium Grade Stone (No.8)
Final Grinding - Fine Grade (No. 120)

13.15.4.3 In all other respects, the process shall be similar as for machine polishing.

13.15.4.4 After the final polish, oxalic acid shall be dusted over the surface at the rates of thirty three (33) gms. per square metre sprinkled with water and rubbed hard with pad of wooden rags. The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

13.15.4.5 If any slab is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with wooden mallet.

13.16 WEAR RESISTANCE FLOORING BY USE OF VACCUM, DEWATERING METHOD AND POWER TROWELLING METHOD WITH A SKIM FLOATER:

1 Concrete shall be laid between the steel forms and a precast concrete rail acting, as a stop end and also rail to be used for surface vibration.

2 The concrete thus laid shall be vibrated with poker vibrator. During poker vibration, proper compaction of coarse aggregates, fine aggregates and cement shall be obtained. The surface will be then finished in level with the help of surface vibrator to give a dense level surface of concrete.

3 Vacuum dewatering method will be used to remove excess water from the laid concrete and filler pad and suction mat shall be laid on the freshly laid concrete which will not allow cement paste to flow out, and the suction pump are then started immediately to remove the excess water. The suction time normally is 20 to 30 minutes. This vacuum process will enable to remove 15 to 25 % of water content and making the surface hard enough to enable to carry the floating operations.

4 The top surface after removal of mat shall be floated with a mechanical skim floater with trowelling blade to enable the top surface to grind and give a uniform water resistance surface on top. Under no circumstances neat Cement be sprinkled directly on concrete surface to absorb bleed water as surface scaling may occur later. Similarly water should not be applied between trowelling operation as it may cause surface weakness. Minimum two passes shall be carried out. The surface shall then be watered and cured as per clause.

The vacuum dewatering process consists of leveling, compacting and vacuum dewatering the concrete flooring by using vibrating screed, vacuum pumps, suction mats, filter pads, accessories etc. The sequence of operation shall be placing of concrete, vibration, vacuum treatment and floating and the operation shall follow immediately behind each other.

The contractor shall have persons well experienced in the vacuum dewatering process, and in the operation of all related equipments. All process equipment to be used shall be in good working condition and shall be subject to the approval of the Engineer.

The work should be planned well in advance with a view to determine areas to be concreted daily, the required number of equipment, size of vacuum mats, length of vacuum hoses, arrangement of rails, screeds etc.

The area to be concreted shall be thoroughly cleaned, reinforced checked and got approved by the Engineer. Then the specified grade of concrete shall be placed in position without any segregation and properly vibrated.

Immediately after placement of concrete, the vibrating screed, fixed at the proper position to achieve the required specified finished level, shall be allowed to run over the concrete on a true surface to level the concrete. For better consolidation proper surcharge of concrete should be maintained in front of the leading edge of the screed and the vibrating screed shall be allowed to move forward rapidly. The concrete surface shall be screeed high by 2 of the slab's thickness to compensate for the compaction caused by the vacuum dewatering process. (Slabs which have an aggregate hardener shall have compensation made to maintain elevation.)

Immediately after leveling the concrete shall be covered with filter pads and suction mats in strict
The vacuum shall be maintained for at least 3 minutes per 25 mm of concrete thickness at 0.80 atmospheres. (Where aggregate hardeners are specified, sufficient moisture shall be maintained to meet Manufacturer's requirements). The suction mats and filter pads shall then be removed and move to the next section in a leapfrog manner. The vacuum dewatering can be stopped when light footprints only are left in the concrete when stepped upon. A suitable suction time can also be checked with a Proctor apparatus, which should show 1.5-2 Kg / sq cm. Upon removal of the suction mats and filter pads the concrete shall be power floated with out delay until all imprints from the vacuum process are removed. If crusting occurs, the floating operation must be delayed till the concrete carries the machine.

The higher speed is recommended for the floating operation. The passes with the floating disc should be made in the junction of two mats in order to avoid risk of cracking.

The vacuum shall be fully dewatered. The suction mat shall extend 100 mm beyond the edge of the filter pad on all sides. The pads shall extend to within 100 mm of the edges of concrete slab, and the mats shall cover entire slab. Before connecting the hose on the suction mat to the vacuum pump, the edges of the mat shall be smoothed to enable an airtight seal to be created. A vacuum shall then be applied to the mat. After a minute the gauge on the vacuum pump should indicate a minimum vacuum of 0.70 atmospheres (24.0 in Hg) and if not, the mat must be checked for leakage. For concrete that dewater rapidly the vacuum should then be maintained at 0.70-0.80 atmosphere (24.0-25.5 in Hg). For concrete which dewater less efficiently (eg. Air-entrained concrete) the vacuum shall then be reduced to 0.50-0.60 atmospheres (15.0-18.0 in Hg). After approximately 10 minutes the vacuum can then be increased to 0.80 atmospheres.

The waiting time after the floating operation depends on concrete temperature and humidity and varies from 10 minutes to 2 hours.

The contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

The contractor shall be required to maintain control charts showing individual test results for aggregate graduation, slump, air content and compressive strength.

The trowelling operation cannot take place before the concrete has hardened enough to carry the machine i.e., the trowelling blades will not leave any marks on the concrete. Repeated trowelling, with intervals between the passes, which are adapted to the setting of the concrete, greatly improves the surface characteristics. The surface will be more wear resistant and less dusty.

Atleast two passes are recommended for floors, which are not to be covered.

Vacuum dewatered concrete should be cured like any quality concrete in order to achieve a good final result. Use curing compounds, plastic sheets or wet burlap.

The contractor has the responsibility for achieving the quality of concrete specified by controlling the concrete mixes, placing, vacuum process, finishing and curing. The concrete technician in charge must be present at the site when work is in progress.

The contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

The contractor shall be required to maintain control charts showing individual test results for aggregate graduation, slump, air content and compressive strength.

Joints in Concrete floor (using sealing compound)

General
Joints shall be of the types and dimensions as indicated and shall be located as indicated.

Dummy Joints
The dummy joints shall be 5 mm wide and shall extend vertically from the surface of the slab to a depth equal to 1/3 to 1/4 of the thickness of the slab. The joint may be formed by depressing into the soft but compacted concrete a high tensile mild steel. 'Tee' or flat bar of depth not less than the required depth of the joint plus 25 mm. The bar used for forming the groove shall be coated with soft seal or other suitable lubricant and have built in handles rigidly fixed to facilitate its removal without spalling or crumbling the edges. When the steel bar is removed, joints shall be nearly reformed immediately with proper tools and with mortar/fine material from the slab itself. No additional cement mortar shall be used. Alternatively the slot may be formed by sawing the concrete with a joint cutting machine (diamond cutter) of approved design within 6 hours of placing under moderate climatic conditions and when the concrete has sufficiently
hardened. Under extreme cold conditions, this period may be suitably increased based on experience. In all cases, except where cutting is done with saw, the joint edges shall be bull nosed. Care shall be taken that the edges of the joints are not damaged. The edge shall not stand proud of the concrete slabs.

Construction Joints
The construction joints shall be 10mm wide and straight and vertical though the full thickness of the slab. The vertical edge of the concrete on the side of the joint shall be treated with a coat of lime wash or bituminous paint before the adjacent bay is concreted. A groove 2.5 cm deep and 1 cm wide shall be formed at the top surface of the joint to receive the sealing compound. The groove shall be formed in the same manner as that for a dummy joint. The edges of the groove shall be bull-nosed and not stand proud of the concrete surface.

Expansion Joints
The expansion joints shall be straight and shall extend through the full thickness of the slab and shall be of the shape and dimensions shown on the drawings. The slab edges adjacent to the joint shall be formed truly vertical. The joints shall be filled with a 2 cm thick filler board. Cold applied joint sealant (polysulphide or polyurethane) of approved make with minimum ten years of performance guarantee will be used as joint sealant. The guarantee should be taken in writing from the contractor before the approval of joint sealants. The technical specifications of the cold applied joint sealants (irrespective of whether polysulphide or polyurethane) should meet the requirements mentioned in BS5212, BS4254 and EN 141875-2003 (for hydrolysis/water resistance test). In addition, the Movement Accommodation Factor (MAF) of the sealant should be minimum ± 30%.

Sealing of Joints
All joints shall be sealed as soon as practicable after 28 days of placing of the slabs. The joints shall be finished flush with the finished concrete surface if the sealing of joints is done in summer and 3mm below the finished concrete surface, if the sealing of joints is done in winter. After the sealing compound has hardened, the excess sealing compound, if any, adhering to the slab outside the joints shall be removed by scraping or otherwise and the surface left clean. The pavement shall be opened to traffic only after the completion of joint sealing over the entire pavement.

Cleaning of Joints
All foreign materials in the joints shall be removed with pneumatic blower. The joints shall, thereafter, be cleaned with a coir brush. Fine particles clinging to the concrete faces shall be removed with the help of an air compressor only to avoid damage to the edges. The joints shall be cleaned and surface dried before the application of primer.

Application of Primer
The cleaned joint shall be primed with a 20-25mm side painter's brush, while painting, light pressure shall be applied so that the primer penetrates into the pores of concrete. The primer shall be applied twice on one side (i.e. by forward and reverse movement of brush). The primer shall be applied in the thinnest possible complete film and then left for some till the primer feels "tacky" soon after the primer is applied, the joint is covered with 10-15 cm wide paper strips so that no dust is deposited on the primer.

Sealant Joints
Only cold applied Polysulphide or Polyurethane joint sealant of approved make will be used in rigid pavements. The criteria for selection of the joint sealant will depend on the minimum performance guarantee of ten years offered by the firm. This performance-based selection would accrue better cost effective results rather than using a joint sealant without any guarantee. The technical specifications of the cold applied joint sealants (irrespective of whether polysulphide or polyurethane) should meet all the requirements mentioned in BS5212, BS 4254 and EN-141875-2003 (for hydrolysis/water resistance test).
While the joints shall be sealed flush with the adjacent pavement surface in summer, in winter they shall be filled to a depth of 3-4mm below the surface. This procedure will reduce the possibility of ingress of grit and other foreign matter into the sealing compound as well as dislodging of the hardened sealing compound under traffic.

Joints in pavement concrete, (using polysulphide polyurethane material)

General

Joint shall be of the types and dimensions specified and be located in all as directed by Gamson Engineer. The edges of the groove/joints shall be bull nosed & not stand proud of the concrete surface.

Dummy Joints

The size of joints shall be as indicated/ specified.

The joint shall be formed using mechanical equipment (diamond cutter) within 6 hour of placing of concrete under moderate climatic conditions and when the concrete has sufficiently hardened. Cutting or sawing by a sawing mounted at movable frame and driven mechanically will also be permitted as a method for making the joint. Care shall be taken that the edge of the joints are not damaged.

In case of sudden rain or storm, the work can be concluded at the dummy joint but the latter will then be formed into a construction joint.

Construction Joints

Construction joints shall also be provided at places where concreting is stopped due to unforeseen circumstances. The size of joints shall be as specified and as shown on drawings.

Construction joints shall be straight and vertical through the full thickness of the slab. The vertical edge of the concrete of the side of the joint shall be treated with a coat of lime wash or bituminous paint before the adjacent bay is concreted. Agroove of dimension as specified in contract shall be formed. The groove shall be formed in the same manner as that for a dummy joint.

Expansion Joints

The expansion joints shall consist of a joint filler board as detailed in the drawing. The depth of the non extruding filler pad (joint filler board) shall be cut by 25mm from top to prepare the joint.

Joints shall be straight and shall extend through the full thickness of the slab and shall be of the shape and dimensions shown on the drawings. The slab edge adjacent to the joint shall be formed truly vertical. The joints shall be filled with approved joint filler as per clause 20.B.7.10.4.

Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with the approved primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape. Bond breaker tape shall be applied on the top face of the pad before inserting the dosed cell backup rod. It shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The faces of the pad against which the new concrete slab is to be laid shall also be painted with the approved primer before laying the concrete. While concreting a neat groove as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

The groove to receive the sealant may be formed by cutting the excess filler board material to the required depth.

Expansion joints shall be provided both longitudinally and transverse direction at spacing as shown on...
Procedure Of Joint Filling With Polysulphide / Polyurethane Sealant

The technical specifications of the cold applied joint sealants (irrespective of whether polysulphide or polyurethane) should meet all the requirements mentioned in BS-5212, BS 4254 and EN-14187-2003 (for hydrolysis/water resistance test). In addition, the Movement Accommodation Factor (MAF) of the sealant should be minimum: f: 30%. The criteria for selection of the joint sealant of approved make will be a minimum performance guarantee of ten years offered by the firm. This performance-based selection would accrue better cost effective results rather than using a joint sealant without any guarantee. Contractor shall not procure the materials required for joint filling unless the samples are approved by the GE and a ten years of guarantee is given in writing by the contractor. The primer and sealant shall got tested by GE from a reputed testing laboratory who has the NABL accreditations like Indian Rubber Manufacturer's Research Association's Laboratory / CRRI/IIT/NIT/SEMT Wing, CME Pune before approval. The test certificate shall be obtained for every 5MT of material incorporated in the work.

Joint Preparation
Before commencing joint sealing operations, the following shall be ensured:-
(a) The groove extends fully across the bay between consecutive longitudinal joints in the case of transverse joints and is continuous in the case of longitudinal joints.
(b) No concrete and foreign matter shall be left in the groove.
(c) In case of expansion joint, the filled materials is exposed to the full length of the joint and expansion joint filler is tightly packed.
(d) Joint surface must be dry, free from dust, coating, bituminous mastics, concrete curing agencies, mould release agents, oil, grease and loose particles.
(e) All joints shall be thoroughly cleaned out by compressed air and sanding with emery paper or other approved means and shall be approved by Engineer-in-Charge before they are sealed.
(f) The cleaned and prepared joints shall be primed on the sides of the joints up to the depth where sealing component is to be provided and filled with approved sealant.
(g) Wipe out oil and grease by solvent soaked cloth (such as Xylene, Toluene or Acetone or Gardoclean).
(h) Before sealing, insert a bond breaker tape and bond breaker (closed cell polyethylene frame rod) caulked tightly into the base of the sealing groove to prevent the sealant from adhering to the base of slot. Width of bond breaker (backup rod) shall be 20 to 25% more than the joint so that there is no seepage of sealant through joints edges.

Fixing/Masking Tape
Fix masking tape to prevent edges of joints becoming dirty due to spillage of sealant at the time of pouring.

Application Of Primer
(i) Suitable primer shall be first applied to the vertical faces of the concrete joint before pouring cold applied sealant confirming to specifications given at clause 20.B.7.1.1.5.1, in order to improve the adhesive qualities of the product. Primer as specified by manufacturers shall be applied to the joint vertical surfaces and allowed to dry for 30 minutes to 2 hours depending on the climatic condition. The surfaces shall be primed twice @ 0.075 litre (minimum) primer per square metre.
(ii) If the primer film has become completely tack free, the surface must be re-primed before applying the sealant.
(iii) If the primed areas are left unsealed overnight the primer film must be removed by grit blasting or grinding and the joints interfaces shall be re-primed.

Mixing
Mixing and application of sealant will be through mechanical means to avoid any human error. The mixed product shall be used immediately as per manufacturer's instructions within its pot life i.e. within 30 minute. The mixed sealant should be kept for a few minutes to allow air to escape before commencement of jointing filling.

Application or Pouring of Sealant
Mixed sealant shall be applied by mechanical means (machine application) based on the
manufacturer’s instructions and shall be executed by his approved and trained applicator. Application temperature of sealant should be in between 5 to 45 degree Celsius (or as per manufacturer's instructions). It should be filled to a level 2 to 3mm below the top of the pavement leaving a recess to protect the sealant from damage. To prevent accidental spillage of sealant on the top surface and to give a neat finish masking tape should be applied on front edges of joint in such a manner that the material will not be spilled on the exposed surface of the concrete. Any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned. All necessary precautions as per the manufacturer's recommendations shall be taken. The sealant should be immediately tooled either with stainless steel or wooden spatula of the size of the joint to give a smooth finish before it begins to set. Masking tape shall be removed immediately after the sealant has been tooled. The sealant should be allowed to cure as per manufacturer's instructions during which period no traffic should be allowed on the pavement.

The test certificate shall be obtained for every 5 MT of material incorporated in the work.

Some Miscellaneous Aspects
(i) The sealant are sensitive to temperature while in storage as well as during mixing. Temperatures for all phase of handling of the sealing compounds viz mixing, placing and curing conditions must be in accordance with manufacturer's recommendations.
(ii) All safety precautions during handing and application of these sealants as prescribed by the manufacturers shall also be strictly adhered to.

Precautions
(a) Some people are sensitive to resins, hardeners, vapour etc. Therefore it is advisable to use hand gloves/ goggles and suitable protective clothing.
(b) Avoid application below 10°C temperature.
(c) Avoid application on damp or moist surfaces.
(d) Do not expose primer to naked flames or other sources of ignition.
(e) Materials to be kept in no smoking area.
(f) Containers should be tightly sealed when not in use.
(g) In the event of fire, extinguish with carbon dioxide or foam.
(h) Should accident skin contact occurs, remove immediately with a resin removing cream, followed by soap and water. Do not use solvent.
(i) In case of contact with eyes, rinse immediately with plenty of clean water and seek medical advise.
(j) Use only in well ventilated areas.
(k) All consumables (masking tape, empty cartridges etc) should be removed and disposed off safely.

13.17 Epoxy Polyurethane Flooring

Scope of work:
The scope work is laying of self leveling epoxy flooring generally consists of following steps
Surface Preparation
Epoxy Primer -
Epoxy Underlay
Epoxy Polyurethane Self leveling Coat

Application instructions:
a) Surface Preparation:
It is essential that surface should be sound, clean and dry surfaces in order that maximum bond strength is achieved between the substrate and the flooring system. All dust and debris should be removed prior to application of the product. All cracks, crevices and undulations shall be filled with epoxy based mortar.

b) Primer application:
Primer coat on the naked surface as a bonding coat and proper drying time should be given to carry out the
Epoxy Flooring

c) Epoxy Underlay -
Generally material is supplied in pre-weighed packs (base and hardener & aggregate), which are ready for immediate on-site use. Part mixing of these components is not acceptable and will affect both performance and appearance of the finished floor. Mixing should be carried out using either a forced action mixer, or a heavy duty, slow-speed drill with proprietary mixing paddle attachment. The components should be mixed in a suitably sized mixing vessel.

- The base component should be added to the mixing vessel first and followed by the hardener and these two components mixed together for approximately 2 minutes until an even colour and texture is obtained.
- Thereafter, the contents of the graded aggregate pack should be slowly added and mixing carried out for a further 3 minutes until a completely homogenous material is obtained.

d) Application of EPU

Mixing
Epoxy polyurethane coating is supplied in pre-weighed packs ready to use on site. Solvent or thinners should not be added. A forced action mixer with a paddle fitted into a heavy duty, slow speed electric hand drill is recommended for mixing. Hardener component is mixed with Base resin in a suitable mixing vessel. The full colour paste is then added and mixed until an even colour is obtained. Finally the filler as supplied is added and mixed further for three minutes until homogenous lump free slurry is obtained.

Laying
The material is poured onto the primed substrate and spread to the required thickness with a steel trowel. Alternatively, a serrated trowel can be used. The resin floor should not be overworked but spread slowly and evenly. Immediately after spreading, the floor should be firmly rolled with a spiked roller to help release any entrapped air in the material and level any slight trowel marks. The floor should now self-smooth to an even coloured dense, impervious floor.

Rate
The rate shall include the cost of all labour and materials involved in all the above operations (including surface preparation) described above.

13.18 ANTI STATIC (CONDUCTIVE) FLOORING SYSTEM

Scope of work:
The scope work is laying of anti static (conductive) flooring system generally consists of following steps
- Surface Preparation, Primer, Antistatic Under Coat, Antistatic Top Coat

NOTE: Moisture insensitive system is an optional only if the moisture content of the floor concrete is > 5

Sequence of Operation for Application of Epoxy Polyurethane Resin Flooring

Moisture Testing
Before the application of epoxy toppings, the concrete substrate shall be checked for moisture content with a Thermo-Hygrometer. For every 500 m2, a minimum of 5 readings should be taken to assess the average moisture content in the substrate. Holes of 16-mm diameter should be drilled to a depth of 50 mm, with a drilling machine. Immediately a slotted sleeve with a cap is to be inserted. 24 hours later, the cap should be removed and the hygrometer's probe should be inserted in the hole and left in place for 1 hour. The meter is than attached to the probe to take the reading. Epoxy topping shall be taken up only if the RH is 75 or lower (5% Moisture content & below)

Surface Preparation

SIGNATURE OF TENDERER WITH SEAL EMPLOYER

Surface shall be attended by Mechanical abrasion method by using Standard equipment. Dust and loose particles shall be cleaned using vacuum cleaners. Neither water wash nor acid etching should be used for cleaning.

Primer Application
The primer shall be solvent free, mixed mechanically using a slow speed heavy duty drilling machine (400 to 500 rpm) fitted with a suitable paddle to achieve homogeneous mix, and shall be applied on the prepared surface. The primer shall be applied in a thin continuous film using a stiff brush or roller over dry surface. Over-application and puddles should be avoided. Primer will act as a key factor for adhesion between the concrete and Epoxy / Polyurethane topping.

Putty Application
Putty shall be applied to fill the micro crevices. Putty shall be mixed and applied using metal float manually to the entire surface and after 24 hrs. Buffing machine shall be used to minimize undulation followed by vacuum cleaning.

**Earthing**

Charge dissipation is the measure of a floor's ability to provide static electricity with a passage to ground potential. This can also be done by coupling the Conductive flooring with self adhesive copper tape @ 600mmx600mm grid, to the earthing point in the Epoxy POLYURETHANE system as shown below.

**Application Of Undercoat**

This provides a conductive passage to earth. Thus strict adherence to coverage rate is critical.

**Application of Topcoat**

The material shall be mixed to achieve a uniform homogenous mix is obtained and spread on the substrate using a notched trowel. The spread material should be rolled firmly using a spiked roller to remove entrapped air and then allowed to set for at least 18 hours.

**Testing Of Conductivity**

Metriso Megger is the instrument used for measuring surface resistance from point to point and point to earth.

**Physical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Requirement</th>
<th>Actual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength</td>
<td>BS63 19</td>
<td>50 N/mm²</td>
<td></td>
</tr>
<tr>
<td>Flexural strength</td>
<td>BS631 9</td>
<td>34 N/mm²</td>
<td></td>
</tr>
<tr>
<td>Tensile strength</td>
<td>BS631 9</td>
<td>16 N/mm²</td>
<td></td>
</tr>
<tr>
<td>Abrasion resistance</td>
<td>Fed. Spec. 141A</td>
<td>97 mg weight loss 0.03 mm depth of wear</td>
<td></td>
</tr>
<tr>
<td>Impact resistance</td>
<td>BS 8204 Part 1</td>
<td>0.2 mm indentation</td>
<td></td>
</tr>
</tbody>
</table>

**Electrical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Requirement</th>
<th>Actual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface resistance</td>
<td>BS 2050</td>
<td>5x10^4Ω to 1 x10^5Ω</td>
<td>1 x10^5Ω</td>
</tr>
<tr>
<td>Charge Decay</td>
<td>Fed test method 101 B, method 4046</td>
<td>5000V to zero in less than 0.1 seconds</td>
<td>0.01 seconds</td>
</tr>
</tbody>
</table>

**Precautions to be taken for the protection and durability of floor. Caution Boards shall be displayed after completion of the work indicating the following:**

1. Light foot traffic can fly only after 24 hours of finishing the floor.
2. However it can be subjected to regular traffic only after 7 days of finishing the treatment, by which time it will have fully cured.
3. Heavy objects or objects with protrusions shall not be dragged on the treated floor surface.
4. All trolleys moving on the floor shall have polyurethane wheels, which will not damage the floor system. Trolleys with MS or CI wheels shall not be used.
5. Hydraulic jacks having metallic pads shall be placed over rubber pads, during operation, to avoid any damage to the floor.

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**

Page 120 of 494
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex) VOLUME –II. TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

6. Any damage or indentation caused to the floor by objects falling on the floor shall be repaired suitably, as per guidelines from manufacturer.

Rate

The rate shall include the cost of all labour and materials involved in all the above operations (including surface preparation) described above.

13.19 Ceramic Glazed Tiles

13.19.1 Ceramic Glazed wall tiles shall be of 1st quality and shall conform to IS :13753. The surface of tiles and components can be smooth, profiled, decorated or finished, glossy, matt or semi-matt as indicated. The tiles shall be flat true to shape, sound and free from flaws and other manufacturing defects. The top surface of the tiles shall be glazed. The underside of the tiles shall be free from glaze in order that the tiles may adhere properly to the base. The glaze shall be uniform in quality and shall be free from welts, chips, craze, crawling or other imperfections, detracting from appearance when viewed at a distance of one meter. The texture and colour of tiles shall be as indicated. Tiles shall be of sizes as indicated. If not indicated size of tile shall be 200mm x 300 mm. The thickness shall be as specified by the manufacturer but in no case it shall be less than 6mm.

13.19.2 Ceramic Glazed floor tiles shall be of 1st quality and shall conform to IS :13755. The surface of tiles and components can be smooth, profiled, decorated or finished, glossy, matt or semi-matt (anti skid) as indicated. The tiles shall be flat true to shape, sound and free from flaws and other manufacturing defects. The top surface of the tiles shall be glazed. The underside of the tiles shall be free from glaze in order that the tiles may adhere properly to the base. The glaze shall be uniform in quality and shall be free from welts, chips, craze, crawling or other imperfections, detracting from appearance when viewed at a distance of one meter. The texture and colour of tiles shall be as indicated. Tiles shall be of sizes as indicated. If not indicated size of tile shall be 300mm x 300 mm. The thickness shall be as specified by the manufacturer but in no case it shall be less than 6.5mm.

13.20 Ceramic Glazed tiles flooring / Ceramic Glazed wall tiles in dado and Skirting

13.20.1 Bedding

The screed bed for laying Ceramic Glazed floor tiles shall be of cement and sand mortar 1:4. Bedding over which the tile shall be laid shall not be less than 10mm at any place. Tiles shall be soaked in water before laying.

13.20.2 Laying

Base concrete or RCC slab shall be cleaned and wetted. The bedding shall then be laid evenly over the surface, tamped and corrected to desired levels and allowed to harden enough to offer a rigid cushion to tiles. Before laying the tiles, cement slurry of honey like consistency at 3 kg/ sq m shall be applied over the bedding. At a time area to accommodate about twenty tiles shall be applied with cement slurry. Tiles shall then be washed clean and fixed in the grout one after the other, each tile being gently tapped in its position.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
till it is properly bedded and in level and line with adjoining tiles. The joints shall be as thin as possible but not exceeding 1.5mm wide. The ceramic tiles shall be set, jointed with cement slurry and pointed in neat coloured cement to match the colour of tiles. The surface shall be cured for seven days and then washed clean.

In the cases of skirting and dado, the wall surface shall be covered with about 10mm thick plaster of cement and sand mortar as indicated and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal lines. The back of tiles shall be buttered with cement paste and set on bedding mortar. The tiles shall be gently tapped in position one after the other. Top of skirting or dado shall be truly horizontal and the joints vertical or as per required pattern. Joints shall be flush pointed with white cement with pigment to match the colour of tiles.

13.21 Vitrified Porcelain Tiles

13.21.1 Vitrified polished porcelain floor tiles shall be of 1st quality. These vitrified tiles are classified under group B1a of the International Standard for ceramic tiles ISO: 13006. Tiles shall be hard, dense, impervious and frost resistant. Water absorption of tiles shall be less than 0.5% and flexural strength (Modulus of Rupture) shall be more than 35 N/Sqmm. Vitrified polished porcelain floor tiles shall be provided of sizes, colour, shades, texture and designs as indicated and if size not indicated it shall be 600mm x 600 mm/ 605 x 605 mm. The thickness shall be as specified by the manufacturer but not less than 8mm.

13.21.2 Heavy duty vitrified unpolished porcelain floor tiles for exterior use shall be of 1st quality. Heavy duty vitrified tiles shall be acid and alkali resistant, weather proof, anti skid and abrasion resistant as per International Standard for ceramic tiles ISO :13006 and EN 176 requirement. These tiles shall comply with the following requirements:

(a) Water absorption<2%
(b) Flexural Strength>35 N/Sqmm
(c) Moh’s Hardness>6
(d) Abrasion resistance<204mm.

Heavy duty vitrified tiles shall be of sizes, colour, texture and designs as indicated but size if not indicated it shall be of 300mm x 300 mm . The thickness shall be as specified by the manufacturer.

13.21a Vitrified Porcelain Tiles flooring

13.21a.1 Bedding

The screed bed for laying Vitrified Porcelain Tiles shall be of cement and sand mortar as indicated. Bedding over which the tiles shall be laid shall not be less than 10mm at any place.

13.21a.2 Laying

Base concrete or RCC slab shall be cleaned and wetted. The bedding shall then be laid evenly over the surface, tamped and corrected to desired levels and allowed to harden enough to offer a rigid cushion to tiles. Before laying the tiles, tiles shall be washed and then applied fine cement slurry on the back of the tile to ensure full and proper bedding. Tiles shall then be placed on bedding, each tile being gently tapped with rubber hammer in its position till it is properly bedded and in level and line with adjoining tiles. Use of spacers is recommended for uniformity in joints and better finish. Remove the residual cement or jointing material immediately by a wet sponge. After 24 hours when the tiles are properly set and cured, fill the joint gaps with joint filler as per recommendation of manufacturer. The joint gap shall be filled by spreading joint filler paste in the spaces between the tiles with the help of rubber trowel. Clean the tiles surface immediately with the help of wet sponge.

Vitrified Porcelain Tiles can be laid in flooring over Base concrete or RCC slab directly by using suitable chemical adhesive as per manufacturer’s instructions if so indicated.

13.22 Precast Cement Concrete Slab Flooring

13.22.1 Cement Concrete of the specified mix shall be mixed precast in forms or mould and cured as
specified for precast articles in Section for Concrete. Unless otherwise indicated, the size of slabs shall not exceed 0.5 Sq m nor be less than 0.1 Sq m. Slabs used in anyone room shall be uniform in size and of thickness as indicated. The top surface of slabs shall be finished fair and smooth (using additional cement where indicated) whilst the concrete is green in forms. Exposed edges shall be perfectly fine, square and well defined.

13.22.2 The slabs shall be bedded and jointed in cement and sand mortar as indicated and Pointed in cement and sand mortars indicated. The thickness of bedding mortar shall be not less than 15mm and thickness of joints shall not exceed 6mm.

13.23 GRANULAR SUB-BASE

13.23.1 SCOPE

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub base hereinafter) as necessary according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

13.23.2 MATERIALS

13.23.2.1 The material to be used for the work shall be natural sand, gravel, crushed stone, or combinations thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to gradings (given below).

While the gradings in Table -1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table -2. The grading to be adopted for a project shall be as specified in the Contract.

13.23.2.2 Physical requirements

The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS : 812 (Part 111). The water absorption value of the coarse aggregate shall be determined as per IS :2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS : 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 per cent.

<table>
<thead>
<tr>
<th>Table -1. Grading for Close-graded Granular Sub-Base Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IS Sieve</strong></td>
</tr>
<tr>
<td>75.0 mm</td>
</tr>
<tr>
<td>53.0 mm</td>
</tr>
<tr>
<td>26.5 mm</td>
</tr>
<tr>
<td>9.50 mm</td>
</tr>
<tr>
<td>4.75 mm</td>
</tr>
<tr>
<td>2.36 mm</td>
</tr>
<tr>
<td>0.425 mm</td>
</tr>
<tr>
<td>0.075 mm</td>
</tr>
<tr>
<td>CBR Value (Min.)</td>
</tr>
</tbody>
</table>
-2. Grading for Coarse Graded Granular Sub-Base Materials

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Grading I</th>
<th>Grading II</th>
<th>Grading III</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0 mm</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53.0 mm</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>26.5 mm</td>
<td>55-75</td>
<td>50-80</td>
<td>100</td>
</tr>
<tr>
<td>9.50 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.75 mm</td>
<td>10-30</td>
<td>15-35</td>
<td>25-45</td>
</tr>
<tr>
<td>2.36 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.425 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.075 mm</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

CBR Value (Min.)

<table>
<thead>
<tr>
<th>Grading I</th>
<th>Grading II</th>
<th>Grading III</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

Note: The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part -5) shall have liquid limit and plasticity index not more than 25 per cent and 6 per cent respectively.

13.23.3 STRENGTH OF SUBBASE

13.23.3.1 It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

13.23.3.2 When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the “quality” of materials, as may be necessary.

13.23.4 CONSTRUCTION OPERATIONS

13.23.4.1 Preparation of sub grade

Immediately prior to the laying of sub-base, the subgrade already finished as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 8-10 Ton smooth wheeled roller.

13.23.4.2 Spreading and compacting

The sub-base material of grading specified in the Contract shall be spread on the prepared sub grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned above, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations. The equipment used for mix-in-place construction shall be a rotator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS : 2720 (Part II) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS : 2720 (Part VIII). While adding water, due allowance shall
made for evaporation losses. After water, has been added, the material shall be processed by mechanical or other approved means like disc hoppers, rotators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 8 to 10 Ton weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 8 to 10 Ton static weight with plain drum or pad footdrum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MN/m or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super elevation and shall commence at the edges and progress towards the centre for portions having crossfall on the both sides. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material determined as per IS : 2720 (Part 7). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

13.23.4.3 Surface Finish and quality Control of Work

The finished surface shall be checked for lines, levels and regularity. The surface evenness of completed surface in longitudinal and transverse direction shall be within the tolerances specified.

13.23.5 MODE OF MEASUREMENTS : The finished area will be measured. Deduction for openings etc. will be made as applicable to flooring as per IS 1200. The surface finish of construction shall conform to the requirements. Granular sub-base shall be measured as finished work in position in cubic metres. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work providing granular sub-base and as such no extra payment shall be made for the same.

SECTION -14

LASTERING AND POINTING

14.1 Indian Standards

The following IS apply to this Section:

<table>
<thead>
<tr>
<th>I.S.No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1542-1977</td>
<td>Specification for sand for plaster (First revision)</td>
</tr>
</tbody>
</table>

142 Definitions

(a) The term 'Plastering' shall cover all type of rough or fair finished plastering, rendering, floating and setting coat or finishing coat, screed, etc., in cement mortar.

(b) "Dubbing out" shall mean filling in hollows in the surface of wall and roughly leveling up irregular or out of Plumb surface prior to rendering.

(c) "Rendering" or "rendering out" shall mean the plaster coat, which is applied following the "Dubbing out" or the final coat in case of one coat work.

(d) "Floating coat" shall mean the second coat in a three coat plaster work, to bring the rendering coat to a true and even surface before the setting or finishing coat is applied.

(e) 'Setting or Finishing coat' shall mean final coat in a two or three coat Plaster work.
(f) Thickness of dubbing out.

(g) The term "even and fair" as referred to finishing of the plastered surface shall mean a surface finished with a wooden float;

(h) The term "even and smooth" as referred to finishing of the Plastered surface shall mean a surface leveled with wooden float and subsequently smoothed with a steel trowel.

MATERIALS

14.3 Cement

Unless otherwise indicated, cement shall be Ordinary Portland Cement 43 grade confirming to IS-8112-1989 as specified in Section for concrete.

14.4 Deleted

14.5 Sand

Unless otherwise indicated, sand for plastering and pointing shall conform to IS 1542-1977, Specification for sand for Plaster. Sand shall consist of natural sand, except where, crushed stone sand or crushed gravel sand or a combination of any of these are indicated. The sand shall be hard, durable, clean and free from adherent coating and organic matter and shall not contain any appreciable amount of clay balls. Sand shall be obtained from approved sources.

14.5.1 Deleterious Materials:

Sand shall not contain any harmful impurities such as iron pyrites, alkalies, salts, coal, mica shade or similar laminated materials, soft fragments, sea shells and Organic impurities in such quantities as to affect adversely the hardening, the strength and the durability or the appearance of the Plaster or applied decoration or to cause corrosion of metal lathing or other metal in contact with Plaster. The maximum quantities of clay, fine silt, fine dust shall be not more than 5 per cent by weight. Origin impurities in the sand shall not exceed the following limit 'that the colour of the "liquid is low that indicated by comparison with the standard solution specified 6.2.2. of IS 2386 (Part II)-1963'.

14.5.2 The particle size grading of sand for plaster and pointing work shall be as under, unless otherwise specified to conform to the sample maintained by the GE for the purpose.

<table>
<thead>
<tr>
<th>IS Sieve designation</th>
<th>Percentage Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>95-100</td>
</tr>
<tr>
<td>1.18mm</td>
<td>90-100</td>
</tr>
<tr>
<td>600 microns</td>
<td>80-100</td>
</tr>
<tr>
<td>300 microns</td>
<td>20-65</td>
</tr>
<tr>
<td>150 microns</td>
<td>0-5</td>
</tr>
</tbody>
</table>

NOTE : Where the grading falls outside the limits of grading zones of sieves other than 600 micron IS sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within the grading. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve size on the finer limit.

NOTE :- Sand whose grading falls outside the above limits shall be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of sand particles.

14.6 Aggregates

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
All aggregates other than sand shall conform to IS 383-1970, Specification for course and fine aggregates from natural sources for concrete. Refer Section 4-concrete.

14.7 Integral Water Proofing Compound

Refer Section 4-Concrete.

14.8 Metal Lathing

Metal Lathing shall be of wire netting or expanded metal is indicated.

14.9 Lime Putty (Neeru)

Lime Putty shall be obtained by slaking fat lime with fresh water and sifting it. Putty shall be kept moist until used and the quantity prepared at a time shall not be more than that can be consumed in 7 days.

14.10 Water

Water used for mixing and curing shall be clean, free from deleterious matter and also from unusual proportions of dissolved salts. Sea water or tidal actuary or brackish water shall not be used. Water fit for drinking is normally suitable.

WORKMANSHIP Scaffolding

Where possible, independent scaffolding shall be used to obviate the subsequent restoration of masonry in put log and other bricks in the work. Stage scaffolding shall be provided for ceiling plaster.

Preparation of Mortar for Plastering and Pointing Cement and Cement Lime Mortar:

These shall be prepared as described in Section 5-brickwork. These shall quantities as required and applied within 30 minutes of mixing.

Proportioning Mixes:

All mixes specified are by volume.

Preparation of Background for Application of Plaster Cleanliness:

All dirt, dust and other foreign matter on masonry and laitance on the concrete surface shall be removed by watering and brushing as required. If the background contains soluble salts, particularly sulphates, the application of plaster shall be done only after the efflorescence of the salt is complete and the efflorescence is completely removed from the surface. Any trace of algae or moss formation shall be removed.

Joints in brickwork, stone masonry and hollow block masonry be racked out to a depth of not less then 10 mm as the work proceeds. Local projections in brickwork and masonry beyond the general wall face shall be trimmed off where necessary.

Roughness:

Smooth surfaces of in-situ concrete walls and ceilings etc. shall be roughened by wire brushing, if it is not hard; and by hacking or bush hammering if it is hard, to provided for proper adhesion. Projecting burrs of mortar because of gaps at joints in shuttling shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surface shall be pock marked with a ponot less then 3 mm deep.

Suction Adjustments:

Adequate drying intervals shall be made by tool at spacing of about 50 mm, the pocks made to be allowed between the erection and plastering to bring the surface suitable for suction adjustment. High rate of suction makes the plaster weak porous and friable. The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry in spots, such areas shall be moistened again to restore uniform suction. Excessive water leads to failure of bound between the plaster and the background.
Evenness:

Any local unevenness must be leveled and projections removed to avoid variance in thickness of plaster.

14.13.6 Immobility

Differential movements between the background and the plaster due to moisture change, temperature change, structural settlement, deflection, etc. causes cracks. The major part of such movements shall be allowed to set in before the plaster is applied.

14.13.7 Precaution against Discontinuity Background:

All straight cut groove through the plaster at the junction of wall to ceiling may be provided where directed.

14.13.8 Holes left in the wall” after removing scaffolding, shall be field up with the respective masonry and the patch plastered up true and in conformity with rest of the wall so that no sign of Patch work shows cut.

14.14 Plastering-Generally

14.14.1 The type and mix of mortar for plastering, the number of coats to be applied, and surface finish of the plaster and the background to which the plaster is to be applied shall be as indicated.

14.14.2 The mortar of dubbing out and rendering coat shall be the same type and mix. Dubbing out may be executed as a separate coat or along with the rendering coat.

14.14.3 Plastering operations shall not be started until all necessary fixtures such as door and window names, mantle pieces are completed and all pipes and conduits to be embedded have been installed and surface to be plastered have been passed by the EIC.

14.14.4 Protection:

All existing work and fitting that are likely to be damaged in the application of plastering shall be protected. Care shall be taken to avoid, as far as possible, the splashing of mortar on to the finished surfaces such as joinery, paintwork and glazing; all such splashes shall be cleaned off immediately.

14.14.5 Screeds 15x15 cm shall be, laid vertically and horizontally not more than 2m apart to serve as guide in bringing the work to an even surface.

14.14.6 Plastering shall be done from top to bottom and care shall be taken to avoid joints in continuous surface.

14.14.7 Maintenance of Proper Time Intervals:

To avoid breakdown of adhesion between successive coats, drying shrinkage of first coat shall be allowed to be materially completed before a subsequent coat is applied.

14.14.8 All comers arises angles, junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering of comers, arises and junctions shall be carried out with proper templates to the required size. Plastering of cornices, decorative features, etc. shall normally be completed before the finishing coat is applied.

14.14.9 In suspending the work at the end of the day, the plaster shall be cut clean to the both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scraped clean and wetted with cement slurry before plaster is applied to the adjacent area.

14.14.10 Partially set and dried mortar shall not be retampered for use.

14.14.11 Cleaning on completion: On completion all work affected by plastering and pointing shall be left clean special care shall be taken when removing any set mortar nom glass and joinery, etc. to avoid damaging their surface.
The finished plaster surface shall not show any deviation more than 4 mm when checked with straight edge of 2 m length placed against the surface.

14.15 One Coat Plaster Work

Mortar shall be firmly applied to the masonry walls and well pressed into the joints and forcing it into surface depressions to obtain a permanent bond. The plaster shall be laid in a little more than the required thickness and leveled with the wooden float. On concrete walls, rendering shall be dashed on to roughened surface to ensure adequate bond. The dashing of rendering coat shall be done using a strong whipping motion at right angles to the face of walls. The surface shall be finished even and fair, unless indicated to be finished even and smooth.

14.16 Two coat Plaster Work

14.16.1 First Coat:

The first coat of the specified thickness shall be applied in a manner similar to one coat plaster work. Before the first coat hardness, the surface of the cement plaster shall be scored to provided key for second coat. The rendering coat shall be kept damp for atleast two days. It shall then be allowed to become thoroughly dry.

14.17.3 Finishing coat

Before starting to apply the finishing coat, the second coat shall be damped evenly. Mortar shall be applied from top to bottom, wherever possible, in the operation to eliminate joining marks. The surface shall be finished as specified for one coat plasterwork.

14.18 Neeru Finish

After applying and finishing the undercoats and before they set the finishing coat of specially prepared lime putty about 1.5 mm thick shall be well polished with a trowel.

14.19 Sand faced Plaster

After the undercoat of cement and sand mortar 1:4., not less than 10 mm thick, has been applied and finished, the final coat of cement and sand mortar 1:4 shall be applied to a thickness not less than 5 mm and brought to an even surface with a wooden float. The surface shall than be tapped gently with a wooden float lined with cork to retain a coarse surface texture; care being taken that the tapping is even and uniform.

14.20 Curing

Each coat shall be kept damp, continuously for at least two days. Moistening shall commence as soon as the plaster has hardened sufficiently and is not susceptible to injury. The water shall be applied preferably by using a fine fog spray. Soaking of wall shall be avoided, and only as much water as can be readily absorbed shall be used. Excessive evaporation on the sunny or windward sites of buildings in hot dry weather shall be prevented by hanging matings or gunny bags on the outside of the plaster and keeping them wet.

14.20.1 After the completion of finishing coat, the plaster shall be kept wet for at least seven days and shall be protected during that period from extremes of temperature them wet.

14.21 Water Proofing Plaster

Integral water proofing compound shall be mixed with cement in the proportion indicated by weight Care shall be taken to ensure waterproofing material gets well and integrally mixed with cement and does not run out separately when water is added.

14.22 Metal Lathing

Lathing shall be tightly stretched before nailing and secured with 25 mm galvanized steel staples at 20 cm centers, if the studding is of wood and with 0.90 mm iron tying if the studding is of steel. Edges of lathing shall be lapped 50 mm at the sides and wired together with 1.25 mm tying wire. Overlaps shall not occur at angles or curves. End laps shall occur only at supports. Before plastering the surface of metal ‘lathing shall be brushed over with thin cement slurry.
14.23. **Pointing**

14.23.1 The type and mix of mortar for pointing and the type of pointing shall be as indicated.

14.23.2 **Racking out joints**

Joints of new brick work or block or stone masonry shall be raked out (without damaging the brick work or masonry) when the mortar is green to such a depth that the minimum depth of new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick / block shall not be less than 10 mm. The raked out joints shall be well wetted before application of mortar.

14.23.3 **Application of Mortar and Finishing:**

The mortar shall be pressed firmly into the raked out joints, with a pointing trowel according to the type of pointing required. The mortar shall not be spread over the corners, edges or the surface of the masonry. When pointing is air dry, it shall be rubbed smooth with the trowel and shall then be finished with proper tool. The surface of masonry shall be cleaned of all mortar.

14.23.4 **Pointing on Random Rubble / Polygonal Rubble Stone Masonry:**

The pointing shall follow the natural irregularities in line and surface of stone.

14.23.5.4 **Raised Pointing (Masons V Joints and Bastrad Truck):** Raised pointing shall project from the wall facing with its edges cut parallel so as to have a

14.23.6 **Curing:** The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all dangers

---

### SECTION -15

**WHITE WASHING, COLOUR WASHING AND DISTEMPERING**

15.1. **Indian standards:**

The following IS apply to this section:

<table>
<thead>
<tr>
<th>I.S. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>63 – 1978</td>
<td>Specification for whiting for paints and putty (second revision)</td>
</tr>
<tr>
<td>428 -2000</td>
<td>Specification for distemper, oil emulsion, colour as required (first revision)</td>
</tr>
<tr>
<td>5411-(Part-I)-1974</td>
<td>Plastic emulsion paint part-1 for interior use(first revision)</td>
</tr>
</tbody>
</table>

**MATERIALS**

15.2 **Distemper, Oil Emulsion:**

Distemper of required colour and shade shall be obtained ready mixed conforming to IS: 428-2000 Specification for distemper, oil emulsion. The material shall be in the form of a homogeneous paste free
from odour of putrefaction as such and when mixed with water.

15.3 **Protective Measures:**

Surfaces of doors, windows, floors, articles of furniture, etc., and such other parts of the building not to be treated shall be protected from being splashed upon. Such surfaces shall be cleaned of splashes of white wash, colour wash, distemper, etc. The contractor shall be responsible for any damage to the fittings, fixture and furniture.

15.4 **Scaffolding:**

Wherever scaffolding is necessary, it shall be erected in such a way that, as far as possible, no part of scaffolding shall rest against the surface to be treated. A properly secured and well tied suspended platform (JHOOLA) may also be used. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the walls and floors. For work in ceilings, proper stage scaffolding may be erected, where necessary.

15.5 **Acrylic Distemper**

15.5.1 **Preparation of Acrylic Distemper**

The distemper shall be thinned with water or any other prescribed thinner in the proportion of 1 kilogram of distemper to 600 ml of water or in the proportions as specified by the manufacturers, which shall invariably be followed. Add water slowly to the paste while continuing to stir the mixture.

15.5.2 **Preparation of surfaces**

The surface shall be thoroughly cleaned of dust, dirt efflorescence, chalking, grease, mortar drops and other foreign matter. The surface shall be sand papered with grade I abrasive paper and Dust off to achieve an even and smooth surface. If surface so obtained is uneven, it shall be brought to a perfectly even surface by applying putty and allowing it to dry completely and then it shall be rubbed with the abrasive paper and dusted off.

15.5.3 **Priming Coat.**

Apply a coat of wall primer as per manufacturer’s instructions and allow it to dry for 6 -8 hours. Smoothen the surface by filling dents with thin coats of wall putty and allow drying for 4-6 hours. Sand the surface with Emery paper 180 and wipe clean. Apply another coat of primer and allow drying for 6 -8 hours. Sand the surface with Emery paper 320 and wipe clean.

15.5.4 **Application of Acrylic Distemper.**

After the priming coat has dried, the surface shall be lightly sandpapered with zero grade abrasive paper, taking care not to rub out the priming coats and then dusted off. Prepared distemper shall then be applied with brushes in coats comprised of horizontal strokes immediately followed by vertical ones which together constitute one coat. Distempering shall always be started from ceiling down. A uniformly finished surface without patches, brush marks distemper drop etc shall be obtained.

15.5.4.1 Distemper shall be applied in dry weather with double bristled distemper brushes. The first coat shall always be of lighter tint than that required finally and the subsequent coat shall be applied only after the previous one has thoroughly dried for at least 24 hours.

15.5.4.2 The distemper shall be thinned and prepared using prescribed thinner as per manufacturer instruction.
15.5.4.3 Workability of acrylic distemper surface shall be tested with wet cloth. Oil bound distemper shall not come out when surface is rubbed with wet cloth.

SECTION 16

GLAZING

16.1 Indian Standards

The following IS apply to this section:

<table>
<thead>
<tr>
<th>IS. No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>419-1967</td>
<td>Specification for putty for use on window frames (First revision)</td>
</tr>
<tr>
<td>2835-1987</td>
<td>Specification for flat transparent sheet glass (Third revision)</td>
</tr>
<tr>
<td>5437-1994</td>
<td>Specification for wired and figured glass (First revision)</td>
</tr>
</tbody>
</table>

16.2 Sun Control Polyester Film-Reflective Type

16.2.1 Sheet Glass

Sheet Glass for glazing shall conform to IS 2835-1987 Specification for that transparent sheet glass and shall be of the following qualities:
(a) ‘A’ quality or selected quality (SQ) for selected glazing, where indicated.
(b) ‘B’ quality or ordinary quality (OQ) for glazing purposes.
(c) ‘C quality or greenhouse quality (GQ) for strips for flooring.

16.2.2 Sheet glass shall be flat transparent and clear as judged by the naked eye. It may, however, possess a light tint when viewed edgewise. It shall be free from any cracks and other defects.

16.2.3 Tolerance on the thickness of glass sheet shall be as under: Normal thickness
16.3 Frosting or Obscuring

The grinding of glass shall be done uniformly and evenly so as to a void any patchy look. The ground glass shall be thoroughly cleaned so that it does not catch stains.

16.4 Grinding, Polishing and Rounding of Edges

The edges of glass when rounded shall present a uniform and neatly finished edge.

16.5 Workmanship

The surface should be free from dust and oil. Sun control polyester film shall be fixed on glass as per manufacturer's instructions.

16.6 Glazing in Steel Surrounds

16.6.1 Glazing with Beads

The glass shall be back puttied and secured in the rebates as specified under “Glazing with putty”. Beads shall be bedded against the glass with putty and secured to frame with screws. An adequate number of screws shall be used so as to prevent flexing or movement of the beads.

16.6.2 Cleaning of glazing

Glass shall be washed with warm water and soap or mild detergent followed by a clean water rinse and dried with cloth or wash leather. Glass with broken or textured surface shall be cleaned with a stiff plastic or bristle brush. For removing any obstinate dirt, glass shall be polished with whiting in water or spirit. Organic solvents may be used for special purposes. Such as petrol or benzene for removing tar, turpentine for paint that has not dried hard and paraffin for grease. The solvent shall be carefully cleaned off the glass afterwards. Plaster or mortar splashes on the glass shall be removed with thin razor blade.

16.7 Anodiscd Aluminium Doors, Windows, Ventilators, Partitions, Composite units etc.

(e) Glazing: Glass panes shall be as indicated. Unless otherwise indicated, fixing of glass panes shall be done with aluminium beading with CP brass or stainless steel screws spaced not more than 10 em from each corner and intermediate not more than 20 em apart. When glass panes are fixed with aluminium beading having mitred joints, epoxy resin or silicon sealant shall be applied between glass panes and sash bars and also between glass panes and beading. Aluminium beading shall also be from firm of sections used for fabrication of aluminium Doors, Windows, Ventilators, Partitions, Composite units etc. Joints shall be filled with PVC/ neoprene felt, cleats etc as indicated.
## SECTION -17

### PAINTING

17.1 **Indian standards**. The following I.S. apply to this section.

<table>
<thead>
<tr>
<th>I.S. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-1978</td>
<td>Colours for ready mixed paint &amp; enamels (third revision)</td>
</tr>
<tr>
<td>75-1973</td>
<td>Linseed oil, raw &amp; refined (Second Revision)</td>
</tr>
<tr>
<td>102-1962</td>
<td>Ready mixed paint, brushing, red lead, nonsetting, priming (Revised)</td>
</tr>
<tr>
<td>104-1979</td>
<td>Ready mixed paint, brushing, zinc chrome, priming (second Revision)</td>
</tr>
<tr>
<td>109-1968</td>
<td>Ready mixed paint, brushing, priming, plaster to IS colour No. 361, Light stone &amp; No. 631 Light grey (First revision)</td>
</tr>
<tr>
<td>157-1950</td>
<td>Ready mixed paint, brushing, acid &amp; alkali resistant, lead free, for general purposes, IS colour No.446 red oxide, No. 537, Signal red No. 632 Dark admiralty grey &amp; black &amp; other colours as required</td>
</tr>
<tr>
<td>158-1981</td>
<td>Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water &amp; heat resisting (Third revision)</td>
</tr>
<tr>
<td>159-1981</td>
<td>Ready mixed paint, brushing, acid resisting for protection against acid fumes colour as required. (First revision)</td>
</tr>
<tr>
<td>162-1950</td>
<td>Ready mixed paint, brushing, fire resisting, silicate type for use on wood colour as required.</td>
</tr>
<tr>
<td>164-1981</td>
<td>Ready mixed pant, brushing, for road marking (First Revision)</td>
</tr>
<tr>
<td>212-1983</td>
<td>Crude coal tar for general use (Second revision)</td>
</tr>
<tr>
<td>218-1983</td>
<td>Creosote &amp; anthracite oil for use as wood preservative (Second revision)</td>
</tr>
<tr>
<td>290-1961</td>
<td>Coal tar black-paint (Revised)</td>
</tr>
<tr>
<td>341-1973</td>
<td>Black Japan, type A, B &amp; C (First revision)</td>
</tr>
<tr>
<td>345-1952</td>
<td>Wood filler, transparent, liquid.</td>
</tr>
<tr>
<td>348-1968</td>
<td>French polish (First revision)</td>
</tr>
<tr>
<td>349-1981</td>
<td>Lacquer, cellulose, nitrate clear, finishing glossy for metal (First revision)</td>
</tr>
<tr>
<td>423-1961</td>
<td>Plastic wood for joiner’s filler (Revised)</td>
</tr>
<tr>
<td>430-1972</td>
<td>Paint remover, solvent type, non-flammable (Second Revision)</td>
</tr>
<tr>
<td>431-1972</td>
<td>Paint remover, solvent type, flammable (Second revision)</td>
</tr>
<tr>
<td>524-1983</td>
<td>Varnish, finishing, exterior synthetic (second revision)</td>
</tr>
<tr>
<td>640-1956</td>
<td>Ready mixed red oxide paint for Hessian (colour unspecified)</td>
</tr>
<tr>
<td>1232-1964</td>
<td>Ready mixed paint, brushing yellow ochre, semi-gloss for general purposes (Revised)</td>
</tr>
</tbody>
</table>
17.2 Paints & Allied Materials-Generally:

17.2.1 All paints & allied materials shall be of quality not inferior to that required by the relevant IS specification. Paints, etc. shall be ready mixed. The colour & tints of paints, unless indicated shall be as approved by the EIC.

17.2.2 The contractor shall inform the EIC, well before he places bulk order for the materials, the names of the brands & manufactures of paints he proposes to use in the works & submit samples thereof & obtain prior written approval of the EIC.

17.2.3 The whole of the materials required for the painting work shall be obtained direct from, approved manufacturers or their authorized agents & shall be brought to the site in makers, drums, kgs, etc. with seals unbroken.

17.2.4 Compatibility of paints:

Before considering the application of undercoats, it shall be made sure that those selected are compatible with each other. The primer, filler, undercoating & finishing paints shall be of paints made by the same manufacturer.

17.2.5 Storage of paints:

All containers of paints, thinners & allied materials shall preferably be stored in well ventilated room free from excessive heat, sparks or flame or direct rays of sun. The containers of paint shall be kept covered or properly fitted with lid & shall be kept open except while using. Materials, which have become stale or fat due to improper & long storage shall not be used or mixed with usable stuff.

17.3 Painting Work-Generally

17.3.1 The type of paint & allied material to be the number of coats to be applied, the preparatory treatment appropriate to the surface & any special process or treatment to be adopted shall be as indicated.

17.3.2 Where more than one coat is indicated, each coat shall be approved, in writing, by EIC before the next coat is applied.

17.3.3 No painting work shall be carried out in wet & very humid weather when there is danger of dew or weather is otherwise unfavourable. No painting or any other process likely to be damaged by dust shall be carried out in windy weather.

17.3.4 Painting except the priming coat shall be taken in hand after all other builder’s work is finished.
17.3.5 The paint in the drum shall be thoroughly mixed prior to application. The materials shall be mixed, prepared & applied strictly in accordance with the instructions or recommendations of the manufacturers except where otherwise directed by the EIC. The paints shall be mixed periodically during brushing.

17.3.6 Addition of Thinners:

Thinners (such as mineral turpentine) shall not be added to paints on the feeling that the consistency of the paint supplied by the manufacturer is too thick. If the paint has been manufactured to conform to the specifications, the paint shall have the correct consistency & shall not require further dilution. If there is any doubt, the viscosity of the paint may be checked. If a slight adjustment of viscosity is necessary thinner, recommended by the manufacturer shall be used after prior approval of EIC.

17.3.7 The surface must be thoroughly dry & clean before painting work is proceeded with at all stages or processes of work. All dust, dirt, rust, & grease shall be removed before painting is started. Painting shall follow immediately after pre-cleaning or pre-treatment; any contamination which may occur in the intervening period shall be removed. Every individual coat shall be properly applied, reasonably level smooth & free from runs & holidays (minute uncovered areas).

17.3.8 Drying Time

For paint film to perform in unison, each coat of paint shall be allowed to dry sufficiently but not excessively before a subsequent coat is applied. Manufacturers' instructions for drying time shall be adhered to properly.

17.3.9 Flattening down :

Cutting of primer & undercoat shall be done to provide a key for subsequent coats. The primer coat, with or without putty, shall be dry cut & the undercoat with or without putty for spot work, shall be wet cut with waterproof emery paper No. 220/240. In the case of under coatings without putty, surface prior to finishing coat, shall be wet cut with waterproof emery paper No. 280/320. The surface shall be dry, clean & free from dust before subsequent coat is applied.

17.3.10 Appearance:

The painted surface shall have a clean uniformly coloured appearance. No hair marks from the brush or clogging of paint puddles in the corner of panels, angles of moulding etc. shall be left on the work.

17.3.11 Colour

Correct colour matching shall be judged against a sample having the same type of surface as that to which the paint has been applied.

17.3.12 In painting doors & windows, the putty round the glass panes shall also be painted but care shall be taken to ensure that no paint, stains, etc. are left on the glass. Tops of shutters & surfaces in similar hidden locations shall not be left out in painting.

17.4 Scaffolding

The scaffolding as required shall be erected for proper execution of work. If the work can be done safely with a ladder or jhoola these may be permitted in the place of scaffolding.

17.5 Brushing of painting

17.5.1 Generally:

Clean pliable brushes free from loose bristles shall be used. Paints shall not show objectionable pulling under the brush. The brush shall be such that the paint does not show lapping streaks & works satisfactorily under it.

17.5.2 Cleaning of paint containers shall be done only with paint thinners, which are compatible with the paint to be filled.
7.5.3 **Brush Application:**

While applying, the paint, the brush shall be held at an angle of approximately 45 degree to the vertical surface & several light strokes applied in the area to be painted., so as to, first transfer the paint to the surface. During painting, the brush shall also be turned around 180 degree in order to ensure that the paint on both the faces of bristles is utilized completely. The paints are then spread with gentle pressure so as to hide the surface & produce a uniform coating. Ensure that the ends & not the sides of the bristles come in contact with the surface during painting. The paint shall be applied, first using vertical strokes until the surface are covered, & then brushed crosswise for complete coverage with light strokes, so as to smooth out laps & brush marks, & finally laid off with vertical strokes.

**17.5.4 Conditioning & Maintenance of Brush:**

After each day's work, the brush shall be cleaned in mineral turpentine or any other suitable thinner, ensuring that the paint & pigment are completely removed from the heel of the brush. Warm water & soap shall be used to clean the brushes used in water-bound paints or emulsions.

**17.6 Painting Woodwork**

**Preparing New Surfaces:**

17.6.1 All woodwork shall be dry & free from dust, dirt or any other extraneous material. Paint applied over discoloured sapwood is liable to become discoloured resin from knots tends to exude through the paint. Any such unsound portions shall be cut out & replaced with sound wood. Nails shall be punched well below the surface to provide a firm key for sopping.

17.6.1.1 Flat portion shall be smoothed with abrasive paper used across the grain prior to painting & with the grain prior to straining or if the wood is to be left in its natural colour. Mouldings shall be carefully smoothed with abrasive paper & projecting fibres left after machining shall be removed. Quirks need particular attention.

17.6.1.2 All loose knots shall be removed & the holes filled with well-fitted sound timber set in red or white lead paint & securely pinned. Any knots, resinous streaks or bluish sapwood that are not large enough to justify cutting out, shall be treated with two coats of pure shellac knotting, applied thinly & extended about 25 mm beyond the actual area requiring treatment. Aluminium primer may be used in place of shellac knotting. If the area is small & the wood is not highly resinous, it is permissible, instead of applying two coats of knotting, to apply one coat slightly pigmented with aluminium powder.

**17.6.2 - Priming:**

On clean prepared surfaces, a priming coat of paint, shall be applied by brushing. Unless otherwise directed, the priming coat shall be applied before the woodwork is fixed in position. In case there is already a primer coat but an unsatisfactory one, it shall be rubbed to bare wood & the surface re-primed.

**17.6.3 Stopping & Filling:**

Stopping & filling shall be done after priming.

17.6.3.1 For deep holes, stopping shall be done with plastic wood conforming to IS 423-1961, Specification for plastic wood for joiner's filler. Stopping shall be to the consistency of stiff paste & all holes, cracks & crevices, etc, shall be stopped carefully to a true & level surface.

17.6.3.2 For stopping slight irregularities of surface & shallow indentation, filler conforming 426-1961 Specification for paste filler for colour coats shall be used. For enamel finishes, filler conforming to IS 110-1968, Specification for ready mixed paint brushing, grey filler, for enamels for use over primers shall be used.

Filler coat, where indicated, shall be applied with a putty knife & subsequently rubbed down to a level surface with abrasive paper or pumice stone. The filler coat shall be of an optimum thickness & shall be allowed to fully harden flatten before subsequent coat is applied. As many layers or filler as necessary shall be applied allowing each coat to harden & flatten before next coat is applied.
17.6.4 Under Coating:

Under coat shall be applied by brush after the surface has been primed, stopped, filled & rubbed down to a smooth surface. After drying, the under coat shall be carefully rubbed down & wiped clean before the next coat is applied.

17.6.5 Finishing Coat:

The finishing coat shall be applied by brush. The extend of gloss shall be as directed by the EIC. The finished surface shall be free from hair or brush marks, streaks clogging of paint, puddles in the corner or pave angle of moulding.

17.7 Clear Finishes to Wood Work

17.7.1 Filling:

On hard wood, with large open vessels, filler conforming to IS 345-1952, Specification for wood filler transparent, liquid shall be used. On fine textured wood having minute pores that do not require filling, unfilled drying oils, thin varnishes, lacquer of shellac shall be used. For special stain effect coloured fillers shall be used.

17.7.1.1 Fillers where indicated, shall be heavily applied, to the wood surface by hand using Hessian or jute rag across the grain. It may be rubbed when still wet to get better penetration. After 5 to 10 minutes it shall be wiped off by hand across the grain followed by a light wipe with the grain: The filled surface shall be dried preferably overnight & smoothened with abrasive paper. Finally wipe with a clean soft rag to remove dust & nibs.

17.7.2 Staining:

17.7.2.1 Spirit Stains:

They shall be applied quickly skillfully to avoid patchy effects. If applied to damp wood the dyes in the stains are liable to be thrown out of the grain, & cause discoloration.

17.7.2.4 Oil Stains: Oil stains consist of solutions of oil soluble dyes in linseed oil or of insoluble semitransparent pigments ground in linseed oil & thinned with turpentine or other solvent. Wax may be added to make the stain less penetrating if so directed by EIC. If applied to damp wood they are likely to develop a milky effect or bloom.

Preparation of Surface for Staining:

Surface to be stained shall be scrupulously clean & free from greasy finger marks. It shall be prepared by careful smoothening with fine abrasive paper used in the direction of the grain; scratches across the grain are likely to become stained darker than the rest of the surface. Small cracks or nail holes may be stopped with plastic wood or other suitable, stopping, if spirit stain is to be used. The stopping shall be rubbed down with fine abrasive paper when hard & touched with a little thinned knotting before staining. Where oil stain is to be used stopping shall preferably be done after staining, using tinted or wood filler.

Sizing:

For sizing, where indicated or directed softwood shall be treated with hot weak size of thinned shellac varnish before staining to prevent undue absorption of stain, but an excess of size shall be avoided. To control the depth of colour, however, diluted stain may be made to soak well into the wood. Where size is used, the surface shall be allowed to dry thoroughly before staining. In general, flat surface shall be treated first & mouldings & edges the last.

Application of Stains:

Stains shall be applied by brushing & wiped. The stain shall be so thinned that it can be applied fairly liberally without over-staining. Care shall be taken, especially, on absorbent soft-woods, to stain evenly & without overlapping, spirit stains, in particular require careful & quick applications as they dry very quickly.

17.7.6.1 Plywood:

Plywood is similar to solid wood in its finishing characteristics.

17.7.6.2 Hard Board:

To prevent swelling under the influence of oil paint, a coat of plastic emulsion paint thinned with water or
hellac varnish shall be applied as the first coat & when dry, rubbed down with fine grade abrasive paper & followed, with required undercoating & finishing coats as for the solid wood.

17.7.6.3 **Particle Board:**

The surface shall be filled with thin brushable filler & finished as for solid wood.

17.7.6.4 **Insulation Board:**

Two thin coats of plastic emulsion paint or any other water based paints shall be applied after dusting off the surface & finished as for solid wood.

178 **Painting Steel & Iron work:**

17.8.1 **Preparing new surfaces:**

The surface shall be thoroughly cleaned of dirt, fluxing material, other foreign matter & scraped thoroughly with hand scraper followed by wire brushing first with coarse & then with fine wire brushes & finally sandpapering the surface to remove all mill scale & rust. The surface shall then be wiped finally with mineral turpentine to remove oil, grease & perspiration left by hand marks.

17.8.1.1 Temporary rust protective materials applied to steel sheets to protect during transport & storage shall be removed with suitable solvent as a preliminary to other preparatory treatment.

17.8.1.2 Surfaces already pretreated or primed in a factory shall be carefully inspected and damaged areas shall be thoroughly degreased and cleaned of all rust and touched up.

17.8.2 **Application of Mordant Solution over Galvanised Surfaces:**

Mordant solution shall be composed of soft water 64 parts and copper chloride, copper nitrate, aluminium chloride and hydrochloric acid, each one part; all by weight. New galvanized surfaces and also old galvanized surfaces where ordered by the EIC, shall be treated with mordant solution at the rate of about 5 litres per 100’ sq.m, rubbing the solution on generously with brush or a bundle of rags on a stick. After about half an hour, the surface; will turn grey, any part remaining bright shall be retreated and the entire surface washed down thoroughly with clean cold water and allowed to dry before applying primer.

17.8.3 **Primer Coat:**

Immediately after the preparation of the surfaces priming coat shall be applied by brush, working in the paint into the fine dents and ensuring a continuous film without runs and holidays.

17.8.4 **Filler coat:**

After primer coat is hard dry, the surfaces shall be rough sanded without scratching or in any way damaging the primer coat and surfaces cleaned free from dust. Deep dents and scratches, if any shall be filled with paste filler using a good putty knife pressing firmly into the dents and applying in optimum layers. Each layer shall be allowed to dry hard and then cut down by wet rubbing to a smooth finish.

17.8.4.1 Where indicated, after the paste filler is hard dry, a coat of liquid filler shall be applied by brush to fill all fine dents, allowed to hard dry and then wet rubbed to a smooth finish.

17.8.5 **Under Coating:**

An optimum coat or under coating shall be applied by brush. The film shall be allowed to hard dry, wet rubbed and cut down to a smooth finish ensuring that at no place the under coat is completely removed.

17.8.6 **Finishing Coat:**

Finishing Coat shall be applied by brush. Special care shall be taken while painting over bolts, nuts rivets and overlaps etc.

17.9 **Painting Asbestos Cement Building Products, Plaster, Concrete, Brick and stone Surfaces**
17.9.1 Preparation of Asbestos Cement Surfaces:

The surface shall be cleaned by rubbing with sand paper. Any glazed area shall be roughened. Lapse powdery material after rubbing shall be brushed off. Wire brushes shall preferably be avoided in cleaning operations as they often lead to difficulties from deposited particles of iron causing iron stains.

17.9.2 Preparation of Cement and cement concrete surfaces:

New surfaces to be painted should be dried thoroughly. Before painting the surface shall be thoroughly brushed to remove all dirt and other foreign matter incidental to building operation.

17.9.2.1 Any loose or uneven areas or any major cracks or defects in the cement concrete or plaster background shall be cut out and made good and the repairs allowed to dry thoroughly. Cracks may be wetted thoroughly prior to filling or priming paint may be applied to the sides of crevices to avoid undue absorption of water & subsequent shrinkage & filling. Minor cracks may be filled with cement mortar. Fine cracks in lime plaster may be filled with a mixture of linseed oil putty & white lead.

17.9.3 Preparation of Masonry surface:

All mortar joints shall be brought to a sound condition before painting operations are started. In the case of new brick work painting shall be deferred for at least three months after completion of masonry work & longer if the weather during the period becomes unfavourable for drying. Dirt may be removed by washing with water.

17.9.4. Preparation of surfaces Generally:

17.9.4.1 Any existing paint showing extensive flaking, bleaching, or saponification (as shown by stickiness or the presence of yellow soapy runs) shall be removed by scraping & washing & the surface allowed to dry completely.

17.9.4.2 Any existing fungus or mould growth shall be completely removed. The surface shall be thoroughly scraped & rubbed down with bristle & brush sand paper & then washed down with clean water & allowed to dry.

17.9.4.3 If efflorescence appears, painting shall be deferred until it ceases. Efflorescence shall be removed by -drying brushing, in no case the efflorescence salts shall be removed by washing.

17.9.4.4 Dry distempers and lime wash shall be totally removed prior to re-painting. It may sometimes be necessary to wet the surface before scrapping. This shall not be overdone and all surfaces shall be perfectly dry prior to the application of any priming coat.

17.9.4.5 Local defective patches shall be treated individually by removing all loose or softened paint and bringing forward the treated patches with primer and undercoating before applying a fresh coating over the whole area.

17.9.4.6. Minor defects are frequently more apparent once the priming or the first coat has been applied and if any further stopping or filling is done over the first coat, The area must be brought forward with appropriate paint to restore even porosity over the surface.

17.9.5 Priming Coat:

New surfaces shall be given a printing coat of alkali resistant priming paint conforming to IS 109-1968 or any other primer as recommended by the manufacturer and allowed to dry for at least 48 hours.

17.9.6 Under coating stopping or filling as required shall be carried out before the painting is done. Any crack in between the plaster ad woodwork shall be securely filled; if such cracks are wide, caulking with hemp or similar material may be necessary to support the filling. Undercoat shall then be applied by brush. After drying the coat shall be carefully rubbed down and wiped clean before the next coat is applied.

17.9.7 Finishing Coats:
Finishing coat shall be applied by brush. The extent of gloss shall be as directed by the EIC.

17.15 Wall painting with plastic emulsion paint:

17.15.1 The plastic emulsion paint shall confirm to IS 5411 (part-I) -1974 or IS 5411 (part II) -1972 as indicated.

17.15.2 The surface shall be thoroughly cleaned off dust. The surface shall then be allowed to dry for at least 48 hours. It shall then be sandpapered to give smooth and even surface. Any unevenness shall be made good by applying putty made of plaster of Paris with water on the entire surface including filling up of undulation and then sand papering the same again when surface is dry.

17.15.3 The paint shall then be applied either by brush or by roller.

17.15.4 Each coat of paint shall be allowed to dry before the next coat is applied.

17.15.5 The thinning of emulsion shall be done with water. The quantity of water to be added as per manufacturer's instruction.

17.15.6 No washing shall be done within 3 to 4 week of application.

17.15.7 Precaution:

17.15.7.1 The brush shall be completely dried of Turpentine oil paint by washing with warm soap water before use.

17.15.7.2. The brushes shall be washed in water after use.

17.15.7.3. No oil-based putty shall be used for filling cracks.

17.15.7.4 Splashes in floor shall be cleaned immediately.

17.16 Wall painting with Acrylic Emulsion Paint (Interior / Exterior Walls) Material

17.16.1 The Acrylic emulsion paint shall be of manufacturer as indicated or as approved by GE and of premium quality. The paint shall be 100% Acrylic and semi Acrylic paint shall not be used in the work.

17.16.2 Preparation of Surfaces

17.16.2.1 The surfaces to be applied with Acrylic emulsion paint shall be cleaned to remove loose dirt or dust, lichen, algae, fungi or any organic growth by use of stiff brush. Then the surface is washed well and allows water to dry. All cracks, voids and minor damages shall be patched/ repaired prior to application of paint with white cement putty or with Plaster of Paris.

17.16.2.2 In case of old surfaces where excessive fungal/ algal growth is observed the surface should be bio washed as per manufacturer's instructions. This product is diluted in water before application as per manufacturer instructions and shall be applied with brush. The coat of bio wash shall be allowed to dry for 12-24 hours and then washed with clean water. Allow the wall to dry before it is ready for painting.

17.16.3 Primer Coat

Over this prepared surface apply a coat of acrylic primer as per manufacturer's instructions. This shall be allowed to dry for 4 to 6 hours before application of final paint.

17.16.4 Finishing Coat

Acrylic paint of premium quality 100% Acrylic shall be applied in at least two coats as per manufacturer instructions. The Acrylic paint shall be prepared as per manufacturer’s instructions by adding water in
proportions as suggested. No other thinner shall be used. Paint shall be applied with brushes or roller and shall be allowed to dry for 3 to 4 hours between subsequent coats.

SECTION-18

WATER SUPPLY, PLUMBING DRAINS AND SANITARY APPLIANCES

Indian Standards

The following IS apply to this section:

<table>
<thead>
<tr>
<th>IS Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>210-1978</td>
<td>Specification for grey iron casting (third revision)</td>
</tr>
<tr>
<td>651-1980</td>
<td>Specification for salt glazed stoneware pipes and fittings (fourth revision)</td>
</tr>
<tr>
<td>774-1984</td>
<td>Specification for flushing cisterns syphonic type (fourth revision) for water closets and urinals (valve less)</td>
</tr>
<tr>
<td>781-1984</td>
<td>Specification for Cast copper alloy, screw down, bib taps and stop valves for water services (third revision)</td>
</tr>
<tr>
<td>782-1978</td>
<td>Specification for caulking lead (third revision)</td>
</tr>
<tr>
<td>1239 (part I)-</td>
<td>Specification for mild steel tubes, tubular and other wrought steel fitting, part I, mild steel tubes (fourth revision)</td>
</tr>
<tr>
<td>1979</td>
<td></td>
</tr>
<tr>
<td>1239 (part II)-</td>
<td>Specification for mild steel tubes, tubular and other wrought steel fittings, part II, mild steel tubular and other wrought steel pipe fittings (third revision)</td>
</tr>
<tr>
<td>1982</td>
<td></td>
</tr>
<tr>
<td>1536-1976</td>
<td>Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage (second revision)</td>
</tr>
<tr>
<td>1538 (part I to XXIII)- 1976</td>
<td>Specification for cast iron fittings for pressure pipes for water, gas and sewage (second revision)</td>
</tr>
<tr>
<td>1703-1977</td>
<td>Specification for ball valves (horizontal plunger type) including floats for water supply purposes (second revision)</td>
</tr>
<tr>
<td>1711-1984</td>
<td>Specification for self-closing taps for water supply purposes (second revision)</td>
</tr>
<tr>
<td>726 (part VII)1974</td>
<td>Specification for cast iron manhole covers and frames (second revision)</td>
</tr>
<tr>
<td>1795-1982</td>
<td>Specification for pillar taps for water supply purposes (second revision)</td>
</tr>
<tr>
<td>1879 (part I to X)- 1987</td>
<td>Specification for malleable cast iron pipe fittings (second revision)</td>
</tr>
<tr>
<td>2065-1983</td>
<td>Code of practice for water supply in Buildings (second revision)</td>
</tr>
<tr>
<td>2548 PART I&amp;II)- 1983</td>
<td>Specification for plastic water closet seats and covers (fourth revision)</td>
</tr>
<tr>
<td>25 56(part I)- 1974</td>
<td>General requirements for vitreous sanitary appliances (second revision)</td>
</tr>
</tbody>
</table>
MATERIALS

SUB SECTION –A: WATER SUPPLY

Centrifugally Cast (Spun) Iron Pipes:

Shall conform to IS 1536-1976, Specification for centrifugally cast (spun) iron pressure pipes for water. Spigot and socket pipes shall be of class LA as indicated. The pipes shall withstand the following hydrostatic test pressures after installation, without showing leakage, sweating or defects of any kind:

Class LA 12 Kg/cm²

Cast Iron fittings for Pressure Pipes:

Shall conform to IS 1538 (part I to XXIII)-1 976. Specification for cast iron fittings for pressure pipes for water, gas and sewage. The fittings shall withstand hydrostatic test pressure as given below without showing any leakage sweating or defects of any kind.

Metal used for the manufacturer of pipes and fittings shall be good quality cast iron, not less than grade FG 150 or IS 210-1 978.

1. Cast iron pressure pipes and fittings shall be free from warping and shrinkage defects ,and also defects other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the use of the pipes and fittings.

2. The pipes and fittings shall be such that they could be cut, drilled or machined.

3. In the case of spigot and socketed pipes and fittings, the spigot ends shall be suitably chamfered for smooth entry of the pipe in the socket fitted with the rubber gasket.

4. In the case of flanged pipes and fittings, the flanges shall be at right angles to the axis of the
5. Permissible tolerances on the standard mass of the pipes shall be ±5 percent and of the fittings ±8 percent except for bends and fittings with more than one branch in which case the permissible tolerance shall be ±12 percent. Pipes and fittings of heavier mass than the maximum may be accepted with out any price adjustment provided the pipes and fittings comply in every other respect with the relevant standards.

6. All pipes and fittings shall be coated both externally and internally with a composition having tar or other similar base. The coating shall be smooth and tenacious; and shall not scale off: The inside coating shall not contain any constituent soluble in water or any ingredient which could impart any taste or color, whatsoever, to the potable water after sterilization and washing of the mains. In the case of imperfectly coated pipes and fittings or where coating is damaged, the coating shall be removed and popes and fittings re-coated.

Mild Steel Galvanized Tubes (pipes) and Fittings
Mild Steel Tubes:
Shall comply IS 1239 (part 1)-1979, Specification for mild steel tube tubulars and other wrought steel fittings, part I mild steel tubes. These shall be hot finished welded, electric resistance weld or high frequency induction welded pipes, galvanized, and screwed and socketed. The tubes shall be of light medium or heavy grade as indicated. Each tube shall be supplied with one socket. The end of the socket shall be chamfered internally to prevent damage to the leading thread. Tubes shall be distinguished by color bands, light tubes with yellow, medium tubes with blue and heavy tubes with red band. . .

Tolerance :

Permissible tolerance on the weight of steel tubes shall be as under:

| 1. | Single tube irrespective of the quantity         | (+) 10 percent (-) 8 percent |
| 2. | For quantities of less than 150 m of one size   | (+) 10 percent (-) 8 percent |
| 3. | For quantities of 150 m and over of one size     | (+) 4 percent                |

Tubulars and fittings:

Mild steel tubular and other wrought steel fittings for use with mild steel' tubes shall be galvanized, complying with IS 1239 (part II)-1 982 for mild steel tubulars and other wrought fittings. These may be butt welded or seamless. Fittings may alternatively comply with the requirements of IS 1879 (part I to X)-1987 Specification for malleable cast iron pipe fittings. These fittings shall be galvanized.

1. Tubes and fittings shall be cleanly finished, well galvanized in and out, and reasonably straight and shall be free from scale, cracks. Surface flaws, laminations and other defects, zinc coating shall be uniformly adherent, reasonably smooth and free from such imperfections as flux, dross inclusions, bare patches, pimples, lumpings, -runs, rust stains and blister. All screw threads shall be clean and well cut, the end shall be cut cleanly and square with the axis of tubes. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

2. Tubes of any grade and fittings shall withstand a test hydraulic pressure of 5 mpa without showing defects of any kind.

Unplasticised PVC Pipes

UPVC pipes shall conform to IS 4985-1988, Specification for unplasticised PVC pipes for potable water supply. The pipes shall be reasonably round. Internal and external surfaces of the pipes shall be smooth and clean, reasonably free from grooving and other defects. The ends shall be cleanly put square with the axis of the pipes, UPVC pipes shall be of pressure ratings (working, pressure) as 2.5, 4.5 and 10 kg/sq cm as indicated.

Fittings for use with LDPE and HDPE pipes

Shall be injection moulded or fabricated type conforming to IS 8008 (parts I to VI)-1 976, specification for injection moulded high density polyethylene fittings for potable water supplies or to IS 8360
1. Fittings for unplasticised PVC pipes shall be made of PVC or shall be as recommended by the manufacturers of the pipes used.

**Caulking lead**

Pig lead and wool shall comply with IS 782-1978 specification for caulking lead.

1. Pig lead shall be of uniform quality, clean and free from foreign materials and shall be of uniform softness and capable of being easily caulked and driven.

2. Lead wool shall not contain any sulphur and shall be not manufactured from discarded accumulator battery plates. The lead wool shall consist of fine strands or plaited ribbons of lead. The cross section of individual strand shall be flat. The dimensions in the sectional plane shall be not less than 0.13 mm and not more than 0.9 mm and of length same as the length of the rope.

**Spun Yarn**

Shall be of hemp and of good quality. It shall be free of oil, tar or greasy substances and shall be of sterilized quality.

**Rubber Gasket for Jointing**

Shall comply with IS 5382-1985 Specification for rubber sealing rings for gas mains, water mains and sewers. Rubber rings shall be free from extractable substances, which impart taste, smell or toxicity to water.

---

**SUB-SECTION - B - PLUMBING**

**Plumbers Brass work: Generally**

1. Fittings shall be of approved pattern, type and make and shall conform to the relevant IS specification.

2. All cast fittings shall be sound and free from laps, blow holes and pittings. External and internal surfaces shall be clean, smooth and free from sand burning plugging, stopping or patching of castings shall not be permissible. The bodies, bonnets, spindles and other parts shall be machined true to shape so that when assembled the parts are axial, parallel and cylindrical with surfaces, smoothly finished and are correct in adjustment.

3. Where taps and stop valves, etc, are specified to be nickel/chromium plated the thickness of plating shall not be less than that for the grade specified in the relevant IS specifications. The plating shall be capable of taking high polish and shall not easily tarnish or scale. Galvanization of malleable iron and cast iron bodies shall be done by hot dip process. Mild steel components shall be electro-galvanized.

**BibTap and Stop Valves**

They shall be screw down type and shall conform to IS 781-1984, Specification for cast copper alloy screw down bib taps and stop valves for water services. The spindles, glands, crutches (Handles) washer plates, nuts etc. should be of brass rod (extruded or rolled). The handles shall be crutch or butterfly type as directed. Bib taps shall be polished bright, stop valves shall be polished bright or they may be unpolished 'as cast' finish, as directed. Where indicated bib taps and Stop valves shall be nickel-chromium plated capable of taking high polish. Minimum finished mass of bib taps and stop valves shall be as under:

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Bib Taps</th>
<th>Stop Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internally Threaded</td>
<td>Externally Threaded</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>Kg</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>0.33</td>
</tr>
<tr>
<td>20</td>
<td>0.75</td>
<td>0.675</td>
</tr>
<tr>
<td>25</td>
<td>1.25</td>
<td>1.18</td>
</tr>
<tr>
<td>32</td>
<td>-</td>
<td>1.68</td>
</tr>
<tr>
<td>40</td>
<td>-</td>
<td>2.09</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>3.70</td>
</tr>
</tbody>
</table>
Fancy Bib Taps and Stop Valves

They shall be of cast copper alloy screw down type and shall conform to IS 8931-1978, specification for cast copper alloy fancy bib taps and stop valves for water services. They shall be of approved pattern and shall be nickel chromium plated and of approved pattern, type and make.

The minimum finished mass of fancy bib taps and stop valves shall be as under:-

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Fancy bib Tap Kg</th>
<th>Stop Valve Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.575</td>
<td>0.575</td>
</tr>
<tr>
<td>20</td>
<td>0.900</td>
<td>0.900</td>
</tr>
<tr>
<td>25</td>
<td>-</td>
<td>1.590</td>
</tr>
</tbody>
</table>

Pillar Taps

Pillar taps shall be of brass or bronze and shall conform to IS 1795-1982, Specification for pillar taps for water supply purposes.

Fancy Pillar Taps:

They shall be of cast copper alloy and shall conform to IS 8934-1978, specification for cast copper alloy fancy pillar taps for water services and shall be of approved pattern and shall be as under:

<table>
<thead>
<tr>
<th>Type</th>
<th>Minimum finished-mass in 15 mm size Kg</th>
<th>Stop Valve in 20 mm size Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pillar tap</td>
<td>0.960</td>
<td>1.758</td>
</tr>
<tr>
<td>Fancy pillar taps</td>
<td>0.665</td>
<td>1.030</td>
</tr>
</tbody>
</table>

Self Closing Taps

They shall conform to IS 1711-1984, specification for self-closing taps and shall be of cast iron, malleable iron casting, brass or bronze, as indicated.

Washers for Cold water Taps

Washers for cold water taps shall conform to IS 4346-1982, specification for washers for water taps for cold water services and shall be of good quality fibre specially selected leather or rubber asbestos composition.

Ball Valves

Ball valves shall be of brass or bronze, high pressure type. and shall conform to IS 1703-1977, specification for ball valves (horizontal plunger type) including floats for water supply purposes. The float shall be of polyethylene, high pressure ball valves with float immersed to not more than half its volume shall remain, closed against test pressure of 1.05 Mpa. The minimum finished mass of ball valves exclusive of floats, and the wall thickness of floats

<table>
<thead>
<tr>
<th>Nominal Size (mm)</th>
<th>Ball Valve Kg</th>
<th>Wall thickness of float (Mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.28</td>
<td>1.5</td>
</tr>
<tr>
<td>20</td>
<td>0.45</td>
<td>2.0</td>
</tr>
<tr>
<td>25</td>
<td>0.82</td>
<td>2.5</td>
</tr>
<tr>
<td>32</td>
<td>1.15</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Waste Fittings
Waste fittings shall be of brass chromium plated and shall conform to IS 2963-1979, specification for cast copper alloy waste fittings for wash basins and sinks. Waste fittings shall be of nominal size 32 mm for washbasins and 50 mm for sinks.

**Traps P and S Types**

Traps for wash basins, sinks and baths shall be of cast copper alloy, chromium plated conforming to IS 5219 (part 1)-1 969, Specification for cast copper alloys traps, part I, P and Straps.

**Bottle Traps:**

Copper alloy traps shall be of brass with copper content not less than 56% conforming to IS 5219 (part I)-1969. The traps shall be polished or chromium plated as indicated. Galvanised malleable iron traps shall be of approved manufacturer. Traps for lavatory basins and sinks shall have one inspection eye, fitted with screw plug and washer, while for baths, the traps shall have branches screwed externally, one of which shall be fitted with washered cap and other with a bent tail pipe and union nut for overflow connection. A lose coupling nut shall be fitted to the inlet for coupling to the waste and the outlet shall be either plain tails for lead pipe or screwed with pipe thread and provide with union tail end pipe. The minimum depth of seal shall be 35 mm.

1. The tolerance permissible on weight shall be ±10 percent. Pipes and fittings weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of the standard without any price adjustment.

2. Pipe nails shall be galvanized, chisel pointed, with 8 mm dia shank and 18 mm dia head pipe nails shall be 100 mm long for pipes up to 100 mm dia and 150 mm long for 150 mm dia pipes.

**SUB SECTION-C: DRAINS AND SEWERAGE INCLUDING APPURTenANTS**

**PVC Soil, waste AND RAINWATER (SWR) DRAINAGE PIPES**

PVC (SWR) pipes shall conform to IS 4985(4 GF/CM²). The size of pipes shall be indicated. Rubber rings for the pipes and fittings shall conform to IS 5382.

1. PVC (SWR) fittings shall be used as per recommendations of the manufacturer of the pipes.

In case there is no IS code for the fittings, these shall generally conform to the requirements of BS 4515 DIN 19531 and DIN 19534.

2. PVC (SWR) pipes and fittings shall be strong, dimensionally stable and shall be free from defects.

**Concrete pipes**

1. Reinforced concrete pipes for drains and culverts shall be non-pressure type, class NP2 as indicated; and shall conform to IS 458-1971, specification for concrete pipes with or with out reinforcement. Bends, junctions and specials shall be of cast iron and of suitable size.

2. The ends of concrete pipes shall be suitable for butt end joints. The butt ends shall be prepared for collar joint with grooves. The pipe joints shall be capable of withstanding the same pressure as the pipe.

3. Concrete pipes shall be straight and free from cracks excepting craze cracks. The ends of pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes upto 600 mm diameter and 6 mm in pipes greater than 600 mm in diameter. The outside and inside surface of the pipes shall be smooth, dense and hard and shall not be coated with cement wash or other preparation. The pipes shall be free from...
defects resulting from imperfect grading of the aggregate, mixing or moulding. Pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

Manhole Covers and Frames

1. Manhole covers and Frames shall be of grey cast iron and shall conform to IS 1726-(part I to VII)-1974, Specification for cast iron manhole covers and frames. These shall be of any of the following grades, types and sizes, as indicated.

2. Weights shall be not less than as given below:

3. Covers shall have a raised chequered design to provide an adequate non slip grip. The rise of the chequer shall be not less than 4 mm. Covers' shall have keyholes and shall be provided with lifting keys.

4. The covers and frames shall be cleanly cast and shall be free from air and sand holes and from cold shuts. They shall be neatly dressed. All casting shall be free from voids whether due to shrinkage, gas inclusions or other causes. The covers shall be gas tight and watertight.

5. Manhole covers and frames shall be coated with a black bituminous composition. The coating shall be smooth, and tenacious.

6. The size of covers specified shall be taken as the clear internal dimensions of the frames.

SUB SECTION –D: SANITARY APPLIANCES

Sanitary Appliances

General:
Sanitary appliances shall be of vitreous china, unless otherwise indicated and shall conform to IS 2556 (part 1)-1974, specification for vitreous sanitary appliances, part I, general requirements and shall be approved make. Appliances shall be strong of high grade and shall be coated of all exposed surfaces with an impervious white/color vitreous glaze. The glaze shall be uniform, free from craze and discoloration and shall possess an impervious surface

1. Sanitary appliances shall be of one piece construction. Water closets and urinals shall have an integral flushing rim. Inside of the pans shall be regular and smooth in order to ensure efficient flush.

Wash down water closet:
Water closet shall conform to IS 2556 (part-II)-1981, specification for vitreous sanitary appliances (vitreous china), part II, specific requirements for wash down water closets, and shall be of pattern 1 or 2, as indicated and of height 390mm and 410 mm respectively. Each closet shall have an integral trap either with P or S outlet; trap inlet depth shall be at least 75 mm. The serrated part of the outlet shall not be glazed externally.

Squatting Pans:
Squatting pans shall conform IS 2556 (part III)-1981, Specification for sanitary vitreous appliances (vitreous china) part III, specific requirements for squatting pans Orissa pattern. Size 580x 440 mm, as indicated. The flushing inlet shall be at the narrow end unless indicated. Each pan shall be provided with a 100 mm dia P or S trap with or without an inspection vent as directed. The trap shall be glazed inside. The intake of the pans shall be regular and smooth to ensure an efficient flush.

Wash Basins:
ashbasins shall conform to IS 2556 (part IV)-1972, specification for vitreous sanitary appliances (vitreous china) (part IV) specific requirements for washbasins. The basins shall be of flat back pattern, size 550 x 400mm for lavatory type and 550x460mm Oval for counter type as indicated.

Basins shall be provided with a single or double tap holes as indicated. A suitable tap hole button shall be supplied if the tap is not required in installation. The waste hole shall be either rebated or bevelled internally with an overall dia of 65 mm and a depth of 10 mm. A slot type overflow having an area of not less than 5sq.cm shall be provided at the back of the bowl.

Urinals:

**Half Stall Urinals:**

They shall be flat type and shall conform to IS 2556 (part VI/sec 2) 1974, specification for vitreous sanitary appliances (vitreous china) part VI, specific requirements of urinal sec 2, half stall urinals. These shall be of size 580x380x350 mm as indicated.

**Flushing Cisterns**

Manually operated flushing cisterns shall conform to IS 774-1984. specification for flushing cisterns for water closets and urinals (valveless syphonic type). Cisterns shall be of Vitrous china or PVC as indicated.

1. The cisterns shall be free from manufacturing and other defects. All working parts shall operate smoothly and efficiently. Cisterns shall be mosquito proof i.e. there shall be no clearance anywhere, which would permit 1.6mm wire to pass through.

Cisterns shall operate on valveless siphon principle. The discharge rate of the cistern shall be about 5 liters in 3 seconds. The cisterns shall have a discharge capacity of 10 or 12.5 liters as indicated, with a tolerance of ±1/2litre. Ball valves shall be of 15 mm, nominal size and shall conform to IS 1703-1977.

**Plastic water Closet Seats and Covers**

These shall conform to IS 2548, specification for plastic, water closet seats and covers. Seats and covers shall be made of moulded synthetic materials, which shall be tough, hard with Resistance to solvents.

1. The underside of the seats may be either flat or recessed as indicated. Where the underside is flat, the seat shall be of solid moulding, where the underside is recessed the section shall be of adequate strength but shall be not less than 3 mm at any point. Covers shall be not less than 3 mm in thickness at any point. Seats and covers shall have a smooth finish and shall be free from cracks and crevices.

2. The hinging device shall be of brass or bronze, chromium plated and shall be provided with two bolts per seat.

3. Each seat shall be provided with not less than three rubber or plastic buffers of size 25x 40x 10mm for; full rounded seats ‘and not less than four buffers for open front seats which shall be securely fixed to the inside of seat, each cover’ shall be provided with the same number of buffers as for seats.

4. Unless otherwise indicated, seats and covers shall be black in colour.

**Mirror**

Mirror shall be made of selected quality sheet glass not less than 5.5 mm thick with edges rounded or bevelled as indicated. It shall be free from all flaws, specks or bubbles. The glass shall be uniformly silver plated on the back, free from silvering defects. The silvering shall have a uniform protective coating of red lead paint.

**Toilet Paper Holder**
The toilet paper holder shall be of chromium plated brass or vitreous china as indicated and of size and design as approved by the GE. It shall be fixed with chromium plated brass screws and rawls/Phil plugs.

WORKMANSHIP

General Requirements

1. The work shall be carried out generally complying with the requirements of relevant byelaw and rules wherever in force.
2. All water supply, sanitary and plumbing installation work shall be carried out through licensed skilled plumbers.
3. All pipe work shall be laid or fixed as to be completely airtight or watertight as specified.

SUB SECTION-A: WATER SUPPLY

General Requirements

1. Changes in the diameter and in the direction of water mains shall preferably be gradual. No bend or curve in pipelines shall be made which materially diminishes or alters the cross section.
2. All water mains and service and distribution pipes used for water supply for domestic purposes shall be thoroughly and efficiently disinfected as approved by the EIC Before putting into commission.
3. The method of laying cast iron pipes below ground level for water supply and drainage purpose will be as per IS 3114:1985-code of practice for laying cast iron pipes to be followed.
4. No pipe shall be laid or fixed so as to pass into, through or adjoining any sewers, scour out let or drain or any manhole connected therewith nor through any ash pit or any material of such nature that would be likely to cause undue deterioration of the pipe, except where the laying of any pipe through such situations is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means as approved by EIC. Any existing piping or fitting laid or fixed, which does not comply with the above requirement shall be removed and relaid/fixed in Conformity with the above requirement immediately.

Excavation and Preparation Of Trenches

The trenches shall be excavated to the required alignment, size and grade as directed and detailed in section 3 Earthwork.

Pipes laid underground shall have adequate cover i.e., the pipes shall be laid at such depths that they are unlikely to be damaged by frost or traffic loads and vibrations. When a pipeline is under a roadway, normally a minimum cover of 90 cm shall be provided but it may be modified to suit local conditions.

Width of Trench:

Width of the trench at bottom shall be such as to provide 20 cm clearance on either side of the pipe. Additional width shall be provided at positions of sockets & flanges for jointings to be made properly. Trenches shall be of such extra width, where ordered, as will permit the convenient placing of timber supports, planking and strutting.

1. Pipes shall not be laid in ground liable to subsidence but when such a ground cannot be avoided, special precautions shall be taken as ordered by the EIC to avoid any damage to the pipes. Where pipes have to be laid on recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

2. The bottom of the trench excavations shall be carefully prepared so that the barrels of the pipe when laid are well bedded for their whole length on firm surface and are true to line and gradient. Joints holes shall be made to such dimensions as will allow the joints to be conveniently made and thoroughly caulked. Where rock and large stones or boulders are encountered, the trench shall be trimmed to a depth of at least 80 mm below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with stones broken to pass through a sieve of 12.5 mm size and well rammed for a hard bed for pipes.

3. When roads have to be crossed, half the width shall be dug at a time and proper warning
notices, signs and lights shall be displayed and watchmen posted to prevent accidents.

4. Roots of trees within a distance of about 0.5 m from the side of pipe lines shall be removed or killed.

Handling of pipes

While unloading, pipes shall not be thrown down from the trucks or rolled along the hard surfaces. Proper implements, tools and facilities such as derricks, ropes, etc., satisfactory to the EIC shall be provided and used for safe handling and careful lowering of all pipes fittings, valves and hydrants into the excavation in such a manner as to prevent damage to water mains and their protective coating. Pipes over 300 mm dia shall be handled and lowered into excavation with the help of chain pulley blocks.

Detection of Cracks in pipes

All pipes and fittings shall be inspected carefully before being laid. Broken or defective pipes shall not be used and removed from the site of work. Pipes shall be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, confirmation may be obtained by pouring seeps through and shows on the outer surface.

Preparing Pipes

The pipes and fittings shall be carefully cleared of all foreign matter before being laid. They shall be thoroughly brushed out internally with a well fitting hard brush, and after laying, the open end shall be temporarily plugged to prevent ingress of water, soil etc. Precautions shall be taken to prevent floatation of the plugged pipes, should the trench become flooded.

Usage of Anchor and Thrust Blocks in pipe lines:

A) General-Where the thrust is appreciable, concrete blocks shall be provided at all points where movements may occur as indicated.

B) Hydrants-The bowl of each hydrant shall be well braced against a sufficient area of unexcavated earth at the end of the trench with stone slab or concrete backing, or it shall be tied to the pipe with 50 x 6 mm M.S flat clamp or restrained joints as indicated.

C) Laying of Pipes

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe can not be laid with out earth entering it, a heavy, tightly woven canvas hag of suitable size shall be placed over each end and left their until the connection is to be made to the adjacent pipe. During laying operations, no tools, clothing or other materials shall be placed in the pipe.

Laying of pipes shall always proceed up grade of a slope if the pipes have spigot and socket joints, the socket ends shall face up stream. In the case of pipe the joints to be ade with loose collars. The collars shall be slip before the next pipe is laid.

While laying pipes, the trenches shall be kept free from water until the material in the joints hardens. Walking or working on the completed pipe line shall not be permitted until the trench has been back filled to a height of at least 30 cm cover the pipes. After placing length of pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to gradient. The pipe shall be secured in place with approved backfilled material tamped under it except at the socket.

When pipe laying is not in progress the open ends of pipe shall be closed by a water tight plug.

Cutting of Pipe

The cutting of pipe for inserting valves or fittings shall be done in a neat and workman like manner with out damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe.

Jointing of Cast Iron pipe

Jointing of cast iron spigot and socket pipes shall be done with anyone of the following joints as indicated:
Run lead joint (under dry condition) Run Lead Joints:

The spigot shall be centered in the adjoining socket by tightly caulking in sufficient turns of tarred gasket or hemp yarn to leave unfilled half the depth of socket for lead. When gasket or yarn has been caulked tightly home, a jointing ring shall be placed round the barrel and against the faces of the socket. Molten pig lead shall then be poured in to fill the remainder of the socket, the lead shall then be solidly caulked with suitable tools and hammers of not less than 3 kg weight, right round the joint to make up for the shrinkage of the molten metal on cooling and shall be preferably finished 3 mm behind the socket face. The pipes shall be perfectly dry before run lead joints are made, otherwise blowholes may occur in the lead.

The lead shall be heated to proper temperature so that when stirred it will show a rapid change in color. Before pouring, all scum shall be removed. Each joint shall be made in one continuous pouring. Care shall be taken that no dross enters the joints. Spongy or imperfectly filled joints shall be burnt out and re-poured.

1. The joint runner shall fit snugly against the face of the socket and the outside of the pipe shall be dammed with to form a pouring lip to provide for filling the joint flush with the face and to the top of the socket.

2. Any deviation either in plan or elevation less than 11-1/4 ° shall be effected by laying the straight pipes round a flat curve of such radius that the minimum thickness of lead at the face of the socket shall not be reduced below 6mm or the opening between the spigot and socket increased beyond 12 mm at any joint. A deviation of about 2-1/4° can be effected at any each joint this way.

3. The quantity of lead and spun to be used for different sizes of pipes are given as under:

<table>
<thead>
<tr>
<th>Nominal size of Pipe mm</th>
<th>Lead / Joint Kg</th>
<th>Depth of Lead /Joint mm</th>
<th>Spun yarn / joint Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2.2</td>
<td>45</td>
<td>0.18</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
<td>50</td>
<td>0.20</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
<td>50</td>
<td>0.30</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
<td>50</td>
<td>0.35</td>
</tr>
<tr>
<td>300</td>
<td>7.2</td>
<td>55</td>
<td>0.48</td>
</tr>
<tr>
<td>350</td>
<td>8.4</td>
<td>55</td>
<td>0.60</td>
</tr>
<tr>
<td>400</td>
<td>9.5</td>
<td>55</td>
<td>0.75</td>
</tr>
<tr>
<td>450</td>
<td>14.0</td>
<td>55</td>
<td>0.95</td>
</tr>
</tbody>
</table>

NOTE : A variation of 5 % in the specified weight is permissible.

Lead Wool Joint:

When it is impractical or dangerous to use molten lead for joints e.g., incases such as inverted joints or in wet conditions or in exceptional cases joints may, with the approval of the EIC, be made with caulking lead wool and yarn inserted in strings not less than 6 mm thick and caulking repeated with each turn of lead wool or yarn. The whole of the lead wool or yarn shall be compressed into a dense mass. The joint shall then finally finished flush with the face of the socket.

Joints made with lead wool shall comply with all the requirements specified for run lead joints. The quantity of lead wool and spun yarn required for different sizes of pipes shall be as under:

<table>
<thead>
<tr>
<th>Nominal dia pipes Mm</th>
<th>Lead wool required per joint Kg</th>
<th>Depth of lead yarn</th>
<th>lead wool or mm</th>
<th>Spun yarn required per joint Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0.80</td>
<td>19</td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>100</td>
<td>0.90</td>
<td>19</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>150</td>
<td>1.60</td>
<td>23</td>
<td></td>
<td>0.25</td>
</tr>
</tbody>
</table>
NOTE: A variation of 5% in the specified weights is permissible

**Jointing Flanged Pipes:**

The jointing material used between flanges of pipes shall be compressed fibre board or rubber of thickness between 1.5 mm to 3mm. The fibre board shall be impregnated with chemically natural mineral oil and shall have been made and then only back filling shall be done.

Each bolt should be tightened a little at a time, taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

1. **Testing of pipe line:**

Before testing, trench shall be particularly back filled except at joints. Completed pipe line shall be subjected to the following tests:

   a) **Pressure test:** The field test pressure to be imposed shall be not less than the greatest of the following:

      i) One and a half times the maximum sustained operating pressure,

      ii) One and a half times of the maximum pipe line static pressure and

      iii) Sum of the maximum static maximum static pressure and surge pressure subject to the works test pressure. Test shall be conducted as per IS :3114-1985

   b) **Leakage test:** A leakage test shall be conducted concurrently with the pressure test. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section there of within 0.035 N/sq. mm of the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. Pressure at which leakage test will be made shall be indicated.

   \[ q_1 = \frac{(N \times D \times V \times P)}{3.3} \]

   Where, \( q_1 \) = The allowable leakage in Cu.m/hour

   \( N \) = Number of joints in the length of the pipe line

   \( D \) = Diameter in mm

   \( P \) = Average test pressure during the leakage test in Kg/sq.cm.

   c) Should any test disclose leakage greater than that specified above, the defective joints shall be remade until the leakage is within the specified allowance. When the joints are made with lead, leaking joints shall be recaulked until watertight; when joints are made with cement or rubber gasket, such joints shall be cut out and remade.

1. **Flushing and disinfections of mains before Commissioning** shall be carried out as per clause 8 of IS 3114-1985. Code of practice for Laying Cast Iron Pipes.

2. **Laying and jointing of GI Pipes (External work)**

**Trenches:**

The width and depth of trenches for different diameter of GI pipes shall be as under:

<table>
<thead>
<tr>
<th>Dia of Pipe mm</th>
<th>Width Of Trench cm</th>
<th>Depth Of trench cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to 50</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>65 to 100</td>
<td>45</td>
<td>75</td>
</tr>
</tbody>
</table>
At joints the width of trench shall be widened where necessary.

**Cutting and threading:**

Where pipes have been cut or re-threaded, the ends shall be carefully filed out so that no obstruction to follow is offered. The ends of pipe shall be carefully threaded in such a manner as will not result in slackness of joints.

**Jointing:**

Screwed steel pipes shall be jointed with screwed and socked joints using screwed fitting of wrought iron, steel or malleable cast iron. The pipe shall be cleaned and cleared of all foreign matter and any bums from the ends of pipes removed before laying. In jointing the pipes, the inside of the socket and the screwed end of the pipe shall be oiled and rubbed over the white lead and a few strands of fine yam or thread wrapped round the screwed end of the pipe. The end shall be screwed in. sockets, tee etc. Care shall be taken that all the pipes and fitting are properly jointed so as to make the joints completely watertight.

**Testing:**

On completion the pipe line shall be tested to a hydraulic pressure of 6kg / sqcm (6 meter) under working condition of pressure and flow. Any joints found leaking shall be redone and all leaking pipes removed and replaced.

**Laying of GI Pipes (Internal work)**

All important provisions of IS-2065-1983 as applicable shall be complied with the consultation with EIC.

1. GI Pipes and fittings, when fixed above ground shall run on the surface of the walls and ceilings, unless specified to be concealed. Where unavoidable, pipes may be buried for short distance provided adequate protection is given against damage. Where directed by EIC a mild steel tube sleeve shall be fixed where the pipe is passing through a wall or floor for reception of the pipe and to allow freedom of expansion and contraction and other movements. Pipes which are embedded in walls, ceilings, or floors shall be painted with bituminous paint of approved quality. The pipes should not come in contact with lime mortar or lime concrete as pipes are affected by lime.

2. All pipes and fitting shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts. The pipes when fixed shall be 15 mm clear from wall. The clamps shall be embedded in brick work in cement and sand mortar 1:3 and shall be placed at regular intervals in straight lengths as under:

<table>
<thead>
<tr>
<th>Dia of Pipe mm</th>
<th>Interval of Clamps</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal run m</td>
<td>Vertical run m</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>20, 25 &amp; 32</td>
<td>2.5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>40 and 50</td>
<td>3</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>65 and 80</td>
<td>3.5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

The clamps shall be fixed at shorter lengths near the fitting as directed by the EIC.

For GI Pipes 15 to 25 mm diameters, the holes in the walls and floors shall be made by drilling with chisel and jumper and not by dismantling the brickwork or concrete. However for bigger dimensions pipes the holes shall be carefully made of the smallest possible size as directed. After fixing the pipes the hole shall be made good with cement and sand mortar 1:3 and properly finished, to match the adjacent surfaces.

In case of concealed pipe work, chasing may be adopted or pipes fixed in the duct, recess etc. shall be secured by clamps or iron hooks spaced at regular interval provided there is sufficient space to work on the pipes with the usual tools.

**SIGNATURE OF TENDERER WITH SEAL**

EMPLOYER
Jointing of Unplasticised PVC pipes.

1. Solvent Welded Joints:

The technique is used with both spigot as well as spigot and socket type joints in which socket is made specially to from a close on pipe end, and with injection moulded fittings. The pipes shall be cut perpendicular to the axis of the pipe length. Pipe end shall be beveled slightly with a beveling tool (Reamer) at an angle about 30°. The total length of insertion of the fitting socket shall be marked on the pipe and checked how far the pipe end could be inserted into the fitting socket. Attempt shall be made to push the pipe to the marked distance, if not possible, it shall at least be pushed for 2/3 of the distance.

1. Dust, oil, water, grease, etc shall be wiped out with a dry clothe from the surface. Further the grease should be thoroughly removed with a suitable solvent, such as methylene chloride or as an alternative the outside surface of the pipe and the inside of the fitting may be roughed with emery paper.

2. Generous coating of solvent cement shall be evenly applied on the inside of the fittings around the circumference for the full length of insertion and on the outer side of the pipe end up to the marked line with non-synthetic bush of suitable dimension. The pipe shall be pushed into the fitting socket and held for 1 or 2 minutes as otherwise the pipe may come out of the fitting due to the slippery quality of the cement and the tapering inside bore of the fitting. The surplus cement on pipe surfaces shall be wiped out. If the solvent cement has dried up too much or the tapering of the socket is too steep. Jointing will not be proper and pipe will come out of the fitting.

2. Flanged Joints:

For jointing PVC pipes of particularly of large sizes, flanged joint will be made by the compression of a gasket on a ring seal set in the face of flange. Flanges solvent welded to the PVC pipes shall be supplied by the manufacturers along with pipes.

3. Rubber Rig Joints:

Rubber ring joints can provide a watertight seal but not resist pull. As such these may be used only as repair collar and for jointing pipes larger than 110 mm dia. Such joints may be provided on pipes, which are buried in the ground and supported throughout on bedding so that they are not subject to movement and longitudinal pull.

Joints for HDPE pipes:

1. Galvanized iron fittings are suitable where there is no risk of corrosion. In corrosive conditions, rigid PVC fittings shall be used.

1. flanged Joints

It consists of flanges either loose or welded to the pipe ends. It is recommended that suitable metallic backing plates be used to support the polyethylene flanges to enable them to be bolted together. Injection moulded polyethylene flanges with metal inserts of 6 to 9 mm thickness may also be used. In most cases, Sealing is improved by incorporating a natural or synthetic rubber gasket between polyethylene flanges.

Testing of Mains after Laying

After laying and jointing, the mains shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop valve, allowed to stand full of water for a few days if time permits and which ever is greater. The test pressure shall be 5 kg / sq. cm or the maximum working pressure plus 50 %, whichever is greater. The pressure shall be applied by means of manually operated test pump, or in the case of long mains or mains of larger diameter, by a power driven test pump, provide that the pump is not left ended. In either case due precaution shall be taken to that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The test pump having been stopped, the test pressure shall maintain itself with out measurable loss for at least half an hour. The mains shall be tested in sections as the work of laying proceeds. The open end of the main may be temporarily closed for testing under moderate pressure by fitting a watertight expanding plug. The end of the main and the plug shall be secured by struts or otherwise to resist the end thrust of the water pressure in the mains.
If the section of the main tested terminates with a sluice valve, the wedge of the valve shall not be used to retain, the water; inside the valve shall be temporarily fitted with a blank flange or in the case of a socketed valve, with a plug and the wedge placed in the open position while testing.

1. **Testing of Service pipes and Fittings**

When the service is complete, it shall be slowly and carefully charged with water, allowing all air to escape and avoiding all shock or water hammer. The services 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 piping, fittings and appliances shall be checked over for satisfactory functioning support and protection from damage, corrosion, frost. Because of the possibility of damage in transit, cisterns shall be retested for water tightness on arrival on the site, before fixing.

**Fixing Sluice Valve**

1. The valve shall be fully examined and cleared of all foreign matter before being fixed. The fixing shall be done by means of bolts, nuts and 3mm rubber insertions or chemically treated compressed fiber board 1.5 mm minimum thickness with the flanges of spigot and socketed tail pieces drilled to the same specification in the case of spigot and socket pipes and with flanges in case, of flanged pipes. These shall be jointed to the pipe line by means of lead caulked joints.

2. Sluice valves shall be installed with spindle vertical on horizontal pipes and horizontal on vertical pipes. While fixing sluice valves in pipe lines below ground level a clear space of about 200 mm shall be available between the tops of the sluice valve spindle and surface box.

3. Clearance between the top of the stuffing box and the underside of the gland shall be uniform on all the sides; Gland shall not be tightened too hard. The pressure applied shall be just enough to stop leakage. Hemp packing shall be adequately soaked in grease and shall not be allowed to remain dry. The valves shall be tightly closed when being installed. While installing flanged valves, each flange bolt shall be tightened a little at a time, taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after the other is highly undesirable.

4. After installation of the valve, the valve and the pipeline shall be flushed with water to remove any foreign matter that may be present in them.

5. If any leak is detected at the valve seat, applying extra torque on the valve spindle to set right the valve shall not be permitted. The valve seats shall be examined and if necessary repaired by scrapping or replacing where necessary.

6. Care should taken to ensure that the jointing material sets squarely between the flanges of the valves and the pipeline or tails without obstructing the water way and that there are no kinks in the jointing material as might allow leakage in service.

**Fixing Fire Hydrant**

The flanged end of the hydrant shall be fixed to the flanged end of a tee in the water main by means of nuts and bolts and 3 mm rubber insertion or chemically treated compressed fibre board 1.5 mm minimum thickness. This may also be fixed by means of flanged tail piece which may be connected to the water main by cast iron specials.

**Making Connections of G.I distribution with G.I Main**

Making connections of G.I Distribution / service pipes with C.I/G.I Mains shall be done as per clause 9.6 of IS 2065-1 983 code of practice for water supply in building as specified and directed.

**Tapping C.I Mains:**

The use of right-angled non-ferrous metal ferrules of 15 mm bore or less shall only be restricted to service connections from C.I mains of 100 mm bore or more to isolated and odd connections. Otherwise special T-branches of appropriate size and type as directed have to be inserted into the line of the mains for distributions and service connections.
Tapping G.I Main:

A pit of suitable dimensions shall be dug at the point where the connection is to be made with the main and earth removed up to 50 mm below the main. The flow of water in the water main shall also be disconnected by closing the sluice or wheel valves on the mains.

The G.I main shall first be cut. Water if any collected in the pit shall be bailed out and ends of the G.I pipe threaded. The connection of distribution pipe shall then be made by fixing malleable G.I Tee of the required size, and fittings such as jam nut G.I socket connecting piece etc. The portion of the pipe in the pit shall be painted with bituminous paint and encased with sand 150 mm all round. The pit shall be filled with earth in level with the original ground surface, watered, rammed and the area dressed.

Water Storage Tanks

Hoisting of tank into position shall be carried out with proper tackle care being taken that no part of the tank or of the structure is damaged in the operation. The tank shall be placed in position truly level, unless otherwise directed. The joints or connections to the pipes shall be made with boiler screws, unions, tees etc, as directed. Supports for tanks shall be provided as indicated.

18.60.1 PVC Water tank tanks shall be "Rotational moulded polyethylene water storage tanks" as per IS 12791-1989, hoisting and fixing in position, connecting up pipes etc, shall be executed as per manufacturer’s instruction.

SUB SECTION-B: PLUMBING

Fixing Brass or Gun Metal Fittings

The fitting shall be carefully examined and cleared of all foreign matter before being fixed. The fitting shall be fitted in the pipeline in a workman like manner. The joints between fittings and pipes shall be made leak-proof. Defective fittings and joints shall be replaced or redone.

Fixing Stop Valve in G.I pipe line

Cutting GI pipeline

The GI pipe shall be cut to the required length at the position where the meter and stop valve are required to be fixed. The ends of the pipe shall be threaded. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and few turns of spun yarn wrapped round the screwed end of the pipe.

Fixing Stop Valve

The meter and stop valve shall be fixed in position by means of connecting pipes, G.I jam nut and socket, etc. The stop valve shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. The factory seal of the meter shall not be disturbed. Wherever the meter is fixed to a newly fitted pipeline, the pipeline shall be completely washed before fitting the meter.

Pipe Work in Branch connections

All joints in pipe work and of pipe work to appliances shall be made in such a manner as to be airtight and watertight and to remain so during use. Care shall be taken to ensure that no jointing material projects inside the bore for the pipe.

Bends

Bends shall be of long radius where practicable. In case of bends in the bottom most pipes they shall necessarily be of long radius and shall preferably be made of 135° (1/8) bends.

Ample provision shall be made for access to all pipe work; embedding of joints in wall shall be avoided as far as possible.

PVC (SWR) Drainage Pipes. Laying and jointing of pipes
The pipes shall be cleaned from outside spigot end and inside of the sealing groove of the fitting. Lubricant supplied by the manufacturer shall be applied uniformly to the spigot end and sealing ring. Spigot end shall be passed into the socket containing sealing ring until fully home as per manufacturer's instructions.

The method of installation and fixing to walls shall be as per manufacturer's instructions.

All PVC (SWR) Pipes and fittings shall be tested with water to detect any leakage as per manufacturer's instructions.

**SUB SECTION-C: DRAINS AND SEWERS**

**Concrete Foundations, Beds, etc**

1. Concrete foundations to the drain and sewer pipes and the hunching or encasing to the pipes shall be provided as indicated No work shall be covered over or surround with concrete until. It has been inspected and approved by the EIC after testing as specified.

**Bedding:**

The thickness of concrete bed below the barrel of the pipe where indicated shall be not less than 10 cm for pipes upto 150 mm and not less than 15 cm for pipes 150 mm and over in dia. Bedding shall extend laterally 15 cm beyond either side of the barrel of the pipe.

Where bedding only is provided, the concrete shall be brought up at least to the invert level of the pipe to form a cradle.

**Reinforced concrete pipe drains**

**Lowering and laying of pipe:** The laying and joining of pipes shall conform to IS 783 -1985. Pipes shall be jointed with collar joints. The trench shall be checked for proper level, gradient and alignments before lowering the pipes.

**Lowering:** The pipes shall be lowered cautiously to prevent disturbance of the bed and sides of the trench. The heavy pipes shall be lowered by means of proper legs, chain pulley blocks as directed by EIC. Great care should be taken to prevent sand etc. from entering the pipes.

**Laying:**

Laying of pipes shall proceeded upgrade of slopes. Packing of earth underneath the pipes shall not be used for rectifying the error of grade. If required, concrete shall be used for packing.

The ends of the pipes shall be kept closed to keep dirt, mud and foreign materials out. Adequate provisions shall be made to prevent floating of pipe in the event of flooding of trenches.

The body of the pipe for its entire length shall rest on an even bed in the trench and places shall be excavated to receive the collar for the purpose of jointing.

**Jointing of Pipes:**

A few skeins of spun yam soaked in a neat cement wash shall be inserted in the groove at the end of the pipe and the two adjoining pipes putted against each other. The collar then shall be slipped over the joint covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipe:: and inserted in the joint by means of caulking tools from both ends of the collar. More skeins of yam shall be added and well rammed home. The objective of yarn is to center the two ends of the pipes within the collar and to prevent the cement mortar of the joint penetrating to the pipes should be fully served.

Cement mortar 1:2 shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted into the joint. The mortar shall then be punched and caulked into the joint and more cement mortar added until the space of the joint has been fined completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both sides at an angle of 45°.

Any surplus mortar projecting inside the joint is to be removed and to guard against any projections, sack or gunny bags shall be drawn past each joint after completion.
The cement mortar joints shall be cured at least for seven days.

Covering Pipes

No work shall be covered over or surrounded with concrete until it has been inspected and approved by the EIC after testing as specified.

Back Filling

Back filling shall be carried out as specified under Sub-section-A-Water supply.

Connection to an Existing Sewer

Connection to an existing sewer shall, as far as possible, be done at the manholes.

Wherever it is unavoidable to make connection in between two manholes, the work of breaking into the existing sewer and forming the connection shall be carried out as directed by the EIC. Breaking into the sewer shall be effected by the cautious enlargement of a small hole; every precaution shall be taken to prevent any material from entering the sewer. No connection shall be formed in such a way as to constitute a projection into the sewer or to cause any reduction in its effective size.

Testing

Comprehensive tests of all fittings and appliances shall be made by simulating conditions of use. Over flows shall also be examined for obstructions. Leaking or sweating joints shall be remade till these are gas tight or water tight as required.

Smoke Test:

All soil pipes, waste pipes, vent pipes and all other pipes when above ground shall be tested gas tight by a smoke test conducted under a pressure of 25 mm of water 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.

Water Test:

Drains and sewers shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under test. A tolerance of two litres per centimetre of diameter per kilometre may be allowed during a period often minutes. The test shall be carried out by suitably plugging the lower end of the drain and the ends of connection, if any, filling the system with water. A Knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head. Allowance shall be made (or absorption of water by pipes and joints by adding water until absorption has ceased after which the proper test shall commence. Any leakage will be visible and the defective part of the work shall be cut and made good. A slight amount of sweating which is uniform may be overlooked but excessive sweating from a particular pipe or joint shall be watched for and taken as a defect to be made good.

Test for Straightness and Obstruction:

These tests shall be carried out:

(a) by inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints the ball should roll down the invert of the pipe and emerge at the lower end; and

(b) by means of a mirror at one end of the line and lamp at the other end. If the pipeline is straight, the full circle of light can be observed. If the pipeline is not straight, this will be apparent. The mirror will also indicate obstruction in the barrel.

Test Records:
Complete records shall be kept of all tests carried out both during construction and after being put into service.

**SUB SECTION-D: SANITARY INSTALLATION**

**General Requirements**

Setting and bedding of sanitary appliances and fittings shall be done carefully to the required levels.

**Support for Appliances**

Brackets for building in shall be provided with lugs, the length of lugs shall be related to the thickness of the wall and the weights to be supported. Brackets for screwing to wall shall be provided to wall shall be provided with ear holes for fixing screws which shall be screwed into suitable wall plugs. In case of thin partition walls, they shall be bolted through the wall, especially where the appliances are heavy using back plates on the remote sides. It may sometimes be possible to fix appliances on both the sides of a partition by bolting either the appliances or their brackets back to back.

**Chases and Ducts**

All holes, chases and ducts required for pipe work shall be properly provided.

**Delivery of Appliances**

All appliances shall be carefully checked that they are in accordance with the requirements and are free from defects and damage before fixing.

**Sitting of Appliances**

Appliances shall be fixed in the position and at height as indicated by EIC. The outlets of water closet pans and similar appliances shall be examined to see that outlet ends are abutting on the receiving pipes before jointing. Attention shall also be given to the possibility of movement and settlement from other causes, which are liable to cause leakages of the pipe joints and also the noise transmission.

**Protection of Appliances**

Care shall be taken at all times, particularly after fixing, to protect glazed, plated and enamelled surfaces of appliances and fittings from damage. All orifices shall be temporarily plugged during the progress of work to prevent obstructions. Appliances shall finally be cleaned of all marks of cement lime, oil, paint etc.

**Water Closet Squatting Pans Suite Fixing of pan:**

The pan shall be sunk into the floor and embedded in a cushion of average 15 cm cement concrete 1:5:10 or lime concrete 1:2 both preferably using brick ballast 40 mm nominal size. This concrete shall be left 115 mm below the top level of the pan so as to allow for flooring and its bed concrete. The pan shall be provided with a 100 mm trap ‘P’ or ‘S’ type with an approximately 50 mm seal and 50 mm dia vent where required. The joint between the pan and the trap shall be made leak proof with cement and sand mortar 1:1

**Wash Down Water Closet Pedestal Type Suite**

1. The closet shall be fixed to the floor by means of 75 mm long, 6.5 mm diameter counter sunk bolts embedded in concrete floor.

**Fixing of seat and Cover:**

The seat shall be fixed to the pan by means of two 8 mm diameter corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 15 mm of the head. Each bolt shall provided with two suitably shaped washers of rubber or other similar material for adjusting to level of the ‘seat while fixing it to the closet. In addition one 8 mm non-ferrous metal washer shall be provided with each bolt. The other arm of the hinge shall be fixed to the underside of the cover, flush with the surface by means of three nos. 10 mm long wood screws.

**Urinals**
Fixing of Lipped Urinals:

Lipped urinals shall be fixed in position by using wooden plugs and screws. Wooden plugs of suitable size shall be fixed in the wall in cement and sand mortar 1:3. The height of front edge of lipped urinal, from the standing level, shall be 65 cm unless otherwise directed. Each urinal shall be connected to 32 mm dia. waste pipes, which shall discharge into a channel or a floor trap. The connection between the urinal and flush or waste pipe shall be made by means of putty or while lead mixed with chopped hemp.

Wash Basins and Sinks

The basin or sink shall be supported on a pair of cast iron brackets set in cement mortar 1:3 for lighter appliances or embedded in cement concrete 1:2:4 Type B1, blocks 100x75x150 mm in size. The wall plaster on the rear shall be cut to rest over the top edge of the basin where directed. After fixing the basin, the plaster shall be made good and surface finished as directed.

The chromium plated trap and union shall be connected to 32 mm dia waste pipe in case of washbasins and 50 mm waste pipe in case of sinks, which shall be suitably bent towards the wall. Waste pipe shall discharge directly on to a floor or nahani trap or gully trap or into an open channel leading to floor trap, or shall be connected to a waste pipe stack through a floor trap. CP brass union shall not be provided when a surface channel, drain or floor trap is placed from the floor level shall be 80 cm unless otherwise indicated.

Fixing of Mirror

The mirror shall be mounted on 4 mm thick asbestos cement building board or 4 mm thick, 3 ply, plywood with commercial face veneers and shall be fixed in position by means of 4 no. Chromium plated brass screws and cup washers and wooden plugs embedded in walls.

Water Test:

The water test may be applied before the appliances are connected and may be carried out in sections so as to limit the static head to 4.5 m. It is necessary to seal all openings affected by the test and provide support to the plugs used as stoppers.

Smoke Test:

Faults shall be located by pumping smoke into the system with a smoke machine. Care shall be taken to ensure that the system is filled with smoke before sealing with plugs.

Hydraulic Performance:

Discharge tests shall be made on all the appliances, singly and collectively. Obstruction in any of the pipelines shall be traced and the whole system examined for proper hydraulic performance, including the retention of an adequate water seal in each trap.

Pumps & Softener Plant:

Pumps: Multistage pump:

Pumps shall be self-priming type with the following specification. The set of pumps shall comprise of one working and one stand by

1. Transfer pump for 21/1 building:
2. **Transfer pump for soft water:**

<table>
<thead>
<tr>
<th>Liquid to be transferred</th>
<th>Potable water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Ambient</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>7.5 M³/Hr.</td>
</tr>
<tr>
<td>Rate of flow</td>
<td>45M</td>
</tr>
<tr>
<td>Discharge head</td>
<td>As per vendor's list</td>
</tr>
<tr>
<td>Pump make</td>
<td>Vertical/Horizontal to suit</td>
</tr>
<tr>
<td>Pump type</td>
<td>5.5 KW/7.5 HP/2880 RPM</td>
</tr>
<tr>
<td>Motor KW/HP/RPM</td>
<td>F</td>
</tr>
<tr>
<td>Insulation class</td>
<td>AC 3 Phase.</td>
</tr>
<tr>
<td>Type of Duty</td>
<td>SS-304 (Outer sleeve, Impellers, Shaft and Diffuser)</td>
</tr>
<tr>
<td>Power</td>
<td>CI (Pump bracket, base and motor frame)</td>
</tr>
<tr>
<td>Material of construction</td>
<td>Tungsten carbide</td>
</tr>
<tr>
<td>Bearings and sleeves</td>
<td>Mechanical seal</td>
</tr>
<tr>
<td>Shaft sealing</td>
<td>50x40mm</td>
</tr>
<tr>
<td>Suction and delivery</td>
<td></td>
</tr>
</tbody>
</table>

3. **Water Softening Plant**

**PROCESS DESCRIPTION:**

Softening by ion exchange resin is the most common and probably the easiest method of removing hardness (that is calcium and magnesium) from water suitable for utility purpose. As the name implies ion exchange is a process in which undesirable ions are exchanged for more desirable ions. The softening process consists of passing raw water containing hardness through a bed of cation resin in sodium form. The hardness ions Ca & Mg are taken up by resin and in exchange, the sodium ions are relinquished from the resin. This is called the service cycle. Raw water will continue to get softened till the resin gets exhausted. Bringing back the resin to its original form is called regeneration. Softener resin is regenerated by sodium chloride solution. Depending on the softener design, the regeneration may need to be done every day or every few days or every week.

**Scope of Work & Specifications for Equipments:**

**A. Raw Water Feed Pump**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
</tr>
<tr>
<td>Motor</td>
</tr>
</tbody>
</table>
Make: Kirloskar / Equivalent

Flow: 12m3/hr

Head: 35m

B. **Pressure Sand Filter:**

**DESCRIPTION**

Flow: 12.0 m³/hr.
Size: 1100mm Dia x 1800mm Ht.
MOC: FRP
Make: PENTAIR / Eq.
Type of Media: Various Size Of Sand and Pebbles.
Qty. of Media: 1160 Kg.
Operating Pressure: 3.5 kg/cm²
External Piping: UPVC Piping with Manual Multi port valve.

C. **Activated Carbon Filter:**

**DESCRIPTION**

Flow: 12.0 m³/hr.
Size: 1100mm Dia x 1800mm Ht.
MOC: FRP
Make: PENTAIR / Eq.
Type of Media: Granular Activated Carbon
Qty. of Media: 560 Kg.
Operating Pressure: 3.5 kg/cm²

D. **Softener**

**DESCRIPTION**

Quantity: 1 No
Diameter: 1100mm
Height: 1800mm
Normal Flow: 12m³/hr
Maximum Pressure: 3.5Kg/cm²
Minimum Pressure: 2.0Kg/cm²
Bursting Pressure: 10Kg/cm²
M.O.C: MSEP
Pipe Line: 50 NB
Type: Vertical
Valve: Multiport
Resin: Na Based Cation
Resin Make: Thermax / Equivalent
Quantity of resin: 1300 Liters
OBR: 12 Hours

E. **Brine Tank**

**DESCRIPTION**

Quantity: 1 No
Capacity: 1000 Litres
MOC: HDPE
Salt Required: 208 Kg
Water Required: 624 Litres

F. **Pressure Gauge**

**DESCRIPTION**

Quantity: 2 Nos
Dial Range: 0 – 5Kg/cm²
Size: 2.5” Dia
Make: Waaree / Equivalent

G. **Flow Meter**
I. Electrical Work

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H. Pipin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interconnected UPVC Pipes, Fittings and Valves</td>
<td>1 Lot</td>
</tr>
<tr>
<td>Make</td>
<td>Supreme / Prince / Equivalent</td>
</tr>
</tbody>
</table>

Starter will be supplied for the above mentioned Mechanical Equipments.

4. Transfer pump for landscaping water supply:

<table>
<thead>
<tr>
<th>Liquid to be transferred</th>
<th>Potable water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Ambient</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.00</td>
</tr>
<tr>
<td>Rate of flow</td>
<td>18 M3/Hr.</td>
</tr>
<tr>
<td>Discharge head</td>
<td>60M</td>
</tr>
</tbody>
</table>

Pump make | As per vendor's list
Pump type | Vertical/Horizontal to suit
Motor KW/HP/RPM | 11 KW/15HP/2880RPM
Insulation class | F
Type of Duty | SI (Continuous)
Power | AC 3 Phase.
Material of construction | SS-304 (Outer sleeve, Impellers, Shaft and Diffuser)
Bearings and sleeves | Tungsten carbide
Shaft sealing | CI (Pump bracket, base and motor frame)
Suction and delivery | Mechanical seal
Material of construction | 65x50mm

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
19.1 Indian Standards:
The followings IS apply to this section.

<table>
<thead>
<tr>
<th>I.S.No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>269-1989</td>
<td>Specification for ordinary and low heat port land cement (Fourth revision).</td>
</tr>
<tr>
<td>516-1959</td>
<td>Method of test for strength of concrete.</td>
</tr>
<tr>
<td>1199- 1959</td>
<td>Method of sampling and analysis of concrete.</td>
</tr>
<tr>
<td>1203- 1978</td>
<td>Determination of Penetration.</td>
</tr>
<tr>
<td>1205 - 1978</td>
<td>Determination of Softening Point.</td>
</tr>
<tr>
<td>1834 -1984</td>
<td>Specification for hot applied sealing compound for joints in the concrete (First revision).</td>
</tr>
<tr>
<td>1838- (Part 1) 1983</td>
<td>Specification for preformed filler for expansion joints in concrete, non-extending and resilient type (Bitumen impregnated fibre) (First revision).</td>
</tr>
<tr>
<td>2386- (Part 3) 1963</td>
<td>Method of Test for aggregates for concrete Part 3: Specific gravity, density, voids, absorption and bulking.</td>
</tr>
<tr>
<td>2386-(Part 4) 1963</td>
<td>Method of test for aggregates Part IV : Mechanical properties.</td>
</tr>
<tr>
<td>2506 - 1985</td>
<td>General requirement for Concrete Vibrates, Screed Board Type (First revision).</td>
</tr>
<tr>
<td>2720- Part 8: 1983</td>
<td>Method of Test for soils Part 8: Determination of Water Content-Dry Density Relation using heavy compaction (Second revision)</td>
</tr>
<tr>
<td>6241- 1971</td>
<td>Method for Test for Determination of Stripping Value of Road Aggregate</td>
</tr>
<tr>
<td>6925- 1973</td>
<td>Method of Test for Determination of Water Soluble Chlorides in Concrete Admixtures.</td>
</tr>
<tr>
<td>8112 -1989</td>
<td>Specification for 43 Grade ordinary portland cement</td>
</tr>
<tr>
<td>9103 - 1999</td>
<td>Concrete Admixtures - Specification (First revision).</td>
</tr>
</tbody>
</table>

19.1 INTRODUCTION
19.1.1 These specifications shall apply to all such road works as are required to be executed under the Contract or otherwise directed by the Engineer-in-Charge (hereinafter referred to as the E.I.C). In every case, the work shall be carried out in accordance with the latest edition of “Specification for Road and Bridge Works” of Indian Road Congress to the satisfaction of the Engineer and conform to the location, dimensions, lines, grades and cross-sections shown on the drawings or as indicated by the Engineer. The quality of materials, processing of materials as may be needed at the site; salient features of the construction work and quality of finished work shall comply with requirements set forth in succeeding sections. Where the drawings and Specifications describe a portion of the work in only general terms, and not in complete detail, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer are to be fully complied with.

19.2 DEFINITIONS

19.2.1 The words like Contract, Contractor, Engineer (synonymous with Engineer-in-Charge) Drawings, Works, Work site used in these Specifications shall be considered to have the meaning as understood from the definitions of these terms given in the General Conditions of Contract.

19.2.2 The following abbreviations shall have the meaning as set forth below:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard published by the British Standards Institution</td>
</tr>
<tr>
<td>CBR</td>
<td>California Bearing Ratio</td>
</tr>
<tr>
<td>IRC</td>
<td>Indian Roads Congress</td>
</tr>
<tr>
<td>IS</td>
<td>Indian published by the Bureau of Indian Standards</td>
</tr>
</tbody>
</table>

19.3 MATERIALS AND TEST STANDARDS

19.3.1 The relevant standards for materials, as well as the testing procedures, have been indicated at appropriate places in the Specifications.

19.4 SCOPE OF WORK

19.4.1 The work to be carried out under the Contract shall consist of the various items as generally described in the Bid Documents as well as in the Bill of Quantities furnished in the Bid Documents.

19.4.2 The works to be performed shall also include all general works preparatory to the construction of roads and all other related works. The work shall include work of any kind necessary for the due and satisfactory construction, completion and maintenance of the works to the intent and meaning of the drawings and these specifications and further drawings and orders that may be issued by the Engineer from time to time. The scope of work shall include compliance by the Contractor with all general conditions of contract, whether specifically mentioned or not in the various the clauses of these specifications, all materials, apparatus, plant, equipment, tools, fuel, water, strutting, timbering, transport, offices, stores, workshop, staff, labour and the provision of proper and sufficient protective works, diversions, temporary fencing lighting. It shall also include safety of workers, first-aid equipment, suitable accommodation for the staff and workmen, with adequate sanitary arrangements, the effecting on maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or other charges arising out of the erection of works and the regular clearance of rubbish, reinstatement and clearing up of the site as may be required on completion of works safety of the public and protection of the works and adjoining land.

19.4.3 The contractor shall ensure that all actions are taken to build in quality assurance in the planning and execution of works. The quality assurance shall cover all stages of work such as setting out, selection of materials, selection of construction methods, selection of equipment and plant, deployment of personnel and supervisory staff, quality control testing, etc. The work of building in quality assurance shall be deemed to be covered in the...
19.4.4 The Contractor shall furnish at least 15 days in advance his programme of commencement of item of work, the method of working he intends to adopt for various items of work. He shall provide information regarding the details of the method of working, and equipment he proposes to employ and satisfy the Engineer about the adequacy and safety of the same. The sole responsibility for the safety and adequacy of the method adopted by the Contractor will, however, rest on the Contractor, irrespective of any approval given by the E.I.C.

19.5 CONSTRUCTION EQUIPMENT

In addition to the general conditions indicated in the Contract Documents, the following conditions regarding use of equipment in works shall be satisfied:

- The Contractor shall be required to give a trial run of the equipment for establishing their capability to meet the laid down Specifications and tolerances to the satisfaction of the Engineer before commencement of the work.
- All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Engineer.
- All the plant/equipment to be deployed on the works shall be got approved from the Engineer for ensuring their fitness and efficiency before commencement of work;
- Any material or equipment not meeting the approval of the Engineer shall be removed from the site forthwith;
- No equipment will be removed from site without permission of the Engineer; and
- The Contractor shall also make available the equipment for site quality control work as directed by the Engineer.

19.6 CONTRACT DRAWINGS

The Contract Drawings provided for tendering purposes shall be as contained in the Tender Documents and shall be used as a reference only. The Contractor should visualize the nature and type of work contemplated and to ensure that the rates and prices quoted by him in the Bill of Quantities have due consideration of the qualitative and quantitative variations, as may be found at the site and complexities of work involved during actual execution/construction.

19.6.1 The Contract drawings will also include any other drawings which the Engineer may issue from time to time during the currency of the contract.

19.7 SITE INFORMATION

The information about the site of work and site conditions in the Tender Documents is given in good faith for guidance only but the Contractor shall satisfy himself regarding all aspects of site conditions.

19.7.1 The location of the works and the general site particulars are as generally shown on the Site plan / Index plan enclosed with the Tender Documents.

19.7.2 Whereas the right-of-way to the road works shall be provided to the Contractor by the Engineer, the Contractor shall have to make his own arrangement for the land required by him for site offices, labour camps, stores, etc. It is assumed that the Contractor has inspected the quarries, borrow areas etc. before quoting his rates for the work to assess the availability of construction materials in required quantity and quality.

19.8 SETTING OUT

19.8.1 The Contractor shall establish working Bench Marks tied with the Reference Bench Mark in the
area soon after taking possession of the site. The Reference Bench Mark for the area shall be as indicated in the Contract Documents and the values of the same shall be obtained by the Contractor from the Engineer. The working Bench Marks shall be at the rate of four per km and also at or near all drainage structures, over-bridges and underpasses. The working Bench Marks/levels should be got approved from the Engineer. Checks must be made on these Bench Marks once every month and adjustments, if any, got agreed with the Engineer and recorded. An up-to-date record of all Bench Marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Engineer for his record.

19.8.2 The lines and levels of formation, side slopes, drainage works, carriageways and shoulders shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and cross-sections are obtained everywhere.

19.8.3 In order to facilitate the setting out of the works, the centre line of the carriageway must be accurately established by the Contractor and approved by the Engineer. It must then be accurately referenced in a manner satisfactory to the Engineer, every 50 m intervals in plain and rolling terrains and 20 m intervals in hilly terrain and in all curve points as directed by the Engineer, with marker pegs and chainage boards set in or near the fence line, and a schedule of reference dimensions shall be prepared and supplied by the Contractor to the Engineer. These markers shall be maintained until the works reach finished formation level and are accepted by the Engineer.

19.8.4 On construction reaching the formation level stage, the centre line shall again be set out by the Contractor and when approved by the Engineer, shall be accurately referenced in a manner satisfactory to the Engineer by marker pegs set at the outer limits of the formation.

19.8.5 No reference peg or marker shall be moved or withdrawn without the approval of the Engineer and no earthwork or structural work shall be commenced until the centre line has been referenced.

19.8.6 The Contractor will be the sole responsible party for safeguarding all survey monuments, bench marks, beacons etc. The Engineer will provide the Contractor with the data necessary for setting out of the centre line. All dimensions and levels shown on the drawings or mentioned in documents forming part of or issued under the Contract shall be verified by the Contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions or levels. The Contractor shall, in connection with the staking out of the centre line, survey the terrain along the road and shall submit to the Engineer for his approval, a profile along the road centre line and cross-sections at intervals as required by the Engineer.

19.8.7 After obtaining approval of the Engineer, work on earthwork can commence and the profile and cross-sections shall form the basis for measurements and payment. The Contractor shall be responsible for ensuring that all the basic traverse points are in place at the commencement of the contract and if any are missing, or appear to have been disturbed, the Contractor shall make arrangements to re-establish these points. A “Survey File” containing the necessary data will be made available for this purpose. If in the opinion of the Engineer, design modifications of the centre line or grade are advisable, the Engineer will issue detailed instructions to the Contractor and the Contractor shall perform the modifications in the field, as required, and modify the ground levels on the cross-sections accordingly as many times as required. There will be no separate payment for any survey work performed by the Contractor. The cost of these services shall be considered as being included in the cost of the items of work in the Bill of Quantities.

19.8.8 The work of setting out shall be deemed to be a part of general works preparatory to the execution of work and no separate payment shall be made for the same.

19.8.9 Precision automatic levels, having a standard deviation of ±2 mm per km, and fitted with micrometer attachment shall be used for all double run levelling work. Setting out of the road alignment and measurement of angles shall be done by using theodolite with traversing target, having an accuracy of one second. Measurement of distances shall be done preferably using precision instruments like Distomat.

19.9 PUBLIC UTILITIES

Drawings scheduling the affected services like water pipes, sewers, oil pipelines, cables, gas ducts etc. owned by various authorities including Public Undertakings and Local Authorities included in the Contract Documents shall be verified by the Contractor for the accuracy of the information prior to the
commencement of any work.

Notwithstanding the fact that the information on affected services may not be exhaustive, the final position of these services within the works shall be supposed to have been indicated based on the information furnished by different bodies and to the extent the bodies are familiar with the final proposals. The intermediate stages of the works are, however, unknown at the design stage, these being dictated by the Contractor’s methods of working. Accordingly, the Contractor’s programme must take into account the period of notice and duration of diversionary works of each body as given on the Drawings and the Contractor must also allow for any effect of these services and alterations upon the Works and for arranging regular meetings with the various bodies at the commencement of the Contract and throughout the period of the Works in order to maintain the required coordination. During the period of the Works, the Contractor shall have no objection if the public utility bodies vary their decisions in the execution of their proposals in terms of programme and construction, provided that, in the opinion of the Engineer, the Contractor has received reasonable notice thereof before the relevant alterations are put in hand.

No clearance or alterations to the utility shall be carried out unless specially ordered by the Engineer. Any services affected by the Works must be temporarily supported by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the Works.

The Contractor may be required to carry out certain works for and on behalf of the various bodies and he shall also provide, with the prior approval of the Engineer, such assistance to the various bodies as may be authorised by the Engineer.

The work of temporarily supporting and protecting the public utility services during execution of the Works shall be deemed to be part of the Contract and no extra payment shall be made for the same.

The Contractor may be required to carry out the removal or shifting of certain services/utilities on specific orders from the Engineer for which payment shall be made to him. Such works shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.

19.10 PRECAUTIONS FOR SAFEGUARDING THE ENVIRONMENT

19.10.1 General
The Contractor shall take all precautions for safeguarding the environment during the course of the construction of the works. He shall abide by all laws, rules and regulations in force governing pollution and environmental protection that are applicable in the area where the works are situated.

19.10.2 Borrowpits for Embankment Construction

Borrowpits shall not be dug in the right-way of the road. The stipulations in standard Specifications shall govern.

19.10.3 Quarry Operations

The Contractor shall obtain materials from quarries only after the consent of the Forest Department or other concerned authorities is obtained. The quarry operations shall be undertaken within the purview of the rules and regulations in force.

19.10.4 Control of Soil Erosion, Sedimentation and Water Pollution

The Contractor shall carry out the works in such a manner that soil erosion is fully controlled, and sedimentation and pollution of natural water courses, ponds, tanks and reservoirs is avoided. The stipulations in standard Specifications shall govern.

19.10.5 Pollution from Hot-Mix Plants and Batching Plants

Bituminous hot-mix plants and concrete batching plants shall be located sufficiently away from habitation, agricultural operations or industrial establishments. The Contractor shall take every precaution to reduce the levels of noise, vibration, dust and emissions from his plant and shall be fully responsible for any claims for damages caused to the owners of property, fields and residences in the vicinity.

19.10.6 Substances Hazardous to Health

The Contractor shall not use or generate any materials in the works which are hazardous to the health of persons, animals or vegetation. Where it is necessary to use some substances which can cause injury to the health of workers, the Contractor shall provide protective clothing or appliances to his workers.

19.10.7 Use of Nuclear Gauges

Nuclear gauges shall be used only where permitted by the Engineer. The Contractor shall provide the Engineer with a copy of the regulations governing the safe use of nuclear gauges he intends to employ and shall abide by such regulations.

19.10.8 The Contractor must take all reasonable steps to minimise dust nuisance during the construction of the works.

19.10.9 Clearance shall be effected immediately by manual sweeping and removal of debris, or, if so directed by the Engineer, by mechanical sweeping and clearing equipment, and all dust, mud and other debris shall be removed entirely from the road surface. Additionally, if so directed by the Engineer, the road surface shall be hosed or watered using suitable equipment.

19.10.10 Any structural damage caused to the existing roads by the Contractor’s construction equipment shall be made good without any extra cost.

19.10.11 Compliance with the foregoing will not relieve the Contractor of any responsibility for complying with the requirements of any Highway Authority in respect of the roads used by him.

19.11 TRAFFIC SAFETY AND CONTROL

The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the highway under improvement. Before taking up any construction, an agreed phased programme for the
diversion of traffic on the highway shall be drawn up in consultation with the Engineer.

The barricades erected on either side of the carriageway/portion of the carriageway closed to traffic, shall be of strong design to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise.

At the points where traffic is to deviate from its normal path (whether on temporary diversion or part width of the carriageway) the channel for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device to the directions of the Engineer. At night the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-lane traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns/lights.

On both sides, suitable regulatory/warning signs as approved by the Engineer shall be installed for the guidance of road users. On each approach at least two signs shall be put up, one close to the point where transition of carriageway begins and the other 120 metres away. The signs shall be of approved design and of reflectory type if so directed by the Engineer.

19.12 METHODOLOGY AND SEQUENCE OF WORK

Prior to start of the construction activities at site, the Contractor shall submit to the Engineer for approval, the detailed construction methodology including mechanical equipment proposed to be used, sequence of various activities and schedule from start to end of the project. Programme relating to pavement and shoulder construction shall be an integrated activity to be done simultaneously in a coordinated manner. The methodology and the sequence shall be so planned as to provide proper safety, drainage and free flow of traffic.

19.13 APPROVAL OF MATERIALS

19.14 SUPPLY OF QUARRY SAMPLES

Approval of all sources of material for work shall be obtained in writing from the Engineer before their use on the project.

Raw and processed samples of the mineral aggregates from the approved quarry shall be submitted by the Contractor at no extra cost.

19.15 USE OF SURFACES BY CONSTRUCTION TRAFFIC

Ordinarily, no construction traffic shall be allowed on pavement under construction unless authorised by the Engineer. Even in that case the load and intensity of construction traffic should be so regulated that no damage is caused to the subgrade or pavement layers already constructed. Where necessary, service roads shall be constructed for this purpose and the same shall be considered as incidental to the work.

The wheels or tracks of plant moving over the various pavement courses shall be kept free of deleterious materials.

Bituminous base course shall be kept clean and uncontaminated as long as the same remains uncovered by a wearing course or surface treatment. The only traffic permitted access to the base course shall be that engaged in laying and compacting the wearing course or that engaged on such surface treatment where the base-course is to be blinded and / or surface dressed. Should the base course or tack coat on the base course become contaminated, the Contractor shall make good by clearing it to the satisfaction of the Engineer, and if this is impracticable, by removing the layer and replacing it to Specification without any extra cost.
19.16 EARTHWORK EXCAVATION FOR ROADS

SPECIFICATIONS

19.16.1 SCOPE

Roadway and drain excavation shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains, and waterways, in accordance with the requirements of these Specifications and the lines, grades and cross sections shown in the drawings or as indicated by the Engineer. This work shall include the hauling and stacking of or hauling to sites of embankment and subgrade construction, of suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner and the trimming and finishing of the road to specified dimensions or as directed by the Engineer.

19.16.2 CONSTRUCTION OPERATIONS

19.16.2.1 Setting Out

After the site has been cleared the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Engineer they are required for the work.

19.16.2.2 Stripping and storing top soil

When so directed by the Engineer, the top soil existing over the sites of excavation shall be stripped to specified depths constituting horizon ‘A’ and stock piled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs, etc. shall be removed along with their roots, with approval of the Engineer.

19.16.2.3 Excavation -General

All excavations shall be carried out in conformity with the directions laid hereinunder and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as decided upon beforehand.

While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion, water pollution etc.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed by the Engineer. The Contractor shall not excavate outside the slopes or below the established grades or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels on the road shall be made good at the cost of the Contractor with suitable materials of similar characteristics to that removed and compacted to the requirements.

All debris and loose material on the slopes of cuttings shall be removed. No back filling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes. These shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

19.16.2.4 Methods, tools and equipment

Only such methods, tools and equipment as approved by the Engineer shall be adopted/used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

19.16.2.5 Rock excavation

Rock, when encountered in road excavation, shall be removed upto the subgrade top level or as otherwise indicated on the drawings. Where, however, unstable shales or other similar materials are intersected at
the subgrade top level these shall be excavated to the extent of 500 mm below the subgrade top level or as otherwise specified. In all cases, the excavation operations shall be so carried out that at no point on cut formation the rock protrudes above the specified levels provided, however, that a negative tolerance of 150 mm shall be permissible.

Where excavation is done to levels lower than those specified, the excess excavation shall be made good by hand packing with rubble and chips to the designated level and compacted to the satisfaction of the Engineer.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when prised by a crowbar shall be removed.

Where blasting is to be resorted to, the same shall be carried out and all precautions indicated observed.

19.16.2.6 Dewatering

If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to discharge the drained water into suitable outlets as not to cause damage to the works or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

19.16.2.7 Disposal of excavated materials

All the excavated materials shall be the property of the Employer. The material obtained from the excavation shall be used for filling up of (I) road way embankment, (ii) the existing pits in the right-of-way and (iii) for landscaping of the road as directed by the Engineer, including levelling and spreading with all lifts and lead.

All hard materials, such as hard moorum, rubble, etc. not intended for use as above, shall be stacked neatly on specified land as directed by the Engineer with all lifts and lead.

Unsuitable and surplus material not intended for use shall also, if necessary, be transported with all lifts and lead and disposed of at places shown and as directed by the Engineer.

19.16.2.8 Backfilling

Backfilling of masonry/concrete/hume pipe drain excavation shall be done with approved material after concrete / masonry / hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and/or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be refilled to the original surface making due allowance for settlement, in layers generally not exceeding 150 mm compacted thickness to the required density, using suitable compaction equipment such as mechanical tamper, rammer or plate compactor as directed by the Engineer.

19.16.2.9 Preparation of Cut Formation

The cut formation which serves as a subgrade, shall be prepared to receive the sub-base / base course as directed by the Engineer.

Where the material in the subgrade (that is within 500 mm from the lowest level of the pavement) has a density less than the specified, the same shall be loosened to a depth of 500 mm and compacted in layers in accordance with the requirements. Any unsuitable material encountered in the subgrade shall be removed as directed by the Engineer to a depth indicated by the Engineer and replaced with suitable material compacted in accordance with IRC specification.

In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular base or base material as directed by the Engineer, laid and compacted in accordance with the respective specifications for these materials.

19.16.3 MEASUREMENTS FOR PAYMENT
Excavation for roadway shall be measured by taking cross sections at suitable intervals in the original position before the work starts and after its completion and computing the volumes in cubic metres by the method of average end areas for each class of material encountered. Where it is not feasible to compute volumes by this method because of erratic location of isolated deposits, the volumes shall be computed by other accepted methods.

At the option of the Engineer, the Contractor shall leave depth indicators during excavations of such shape and size and in such positions as directed so as to indicate the original ground level as accurately as possible. The Contractor shall see that these remain intact till the final measurements are taken.

For rock excavation, the overburden shall be removed first so that necessary cross sections could be taken for measurement. Where cross sectional measurements could not be taken due to irregular configuration or where the rock is admixed with other classes of materials, the volumes shall be computed on the basis of stacks of excavated rubble after making 35 per cent deduction therefrom. When volumes are calculated in this manner for excavated material other than rock, deductions made will be to the extent of 16 per cent of stacked volumes.

19.17 SLOING

19.17.1 Stone & Boulders for Soling (Sub-base)
Stones for soling (Sub bases) shall be free from laminations, foreign matter, and unsound weathered fragments & shall be granite, trap-basalt-limestone, sandstone-kankar, late rite or any other hard rock as indicated. Stones shall be broken to a size range 100mm to 50mm. Stones shall be obtained from approved quarries/ sources as indicated.

19.17.2 Where soling is of broken boulders or cobble stones, these shall be obtained from as large boulders as available. Cobble stone shall be less than 13 cm when measure across the proudest part in any direction.

19.17.3 Broken Stone Soling
The edges of soling shall be marked out by strings and stakes, carefully ranged. Broken stones/boulders shall be spread uniformly and evenly upon the prepared base, surface carefully trued up and all high and low spots corrected by removing or adding broken stones as may be required. The soling shall be consolidated by a road roller 8 to 10 tones weight in the same manner as described for water bound macadam except that screening and binding material shall not be applied. The finished surface shall be checked for lines, levels and regularity. The surface evenness of completed surface in longitudinal and transverse directions shall be within the tolerances specified.

19.17.4 Brick Soling
Soling of bricks shall be laid in one or two layers flat or on edge, as indicated. Bricks used shall be full size; brickbats shall not be used. Bricks shall be hand laid, with each brick as far as possible touching the other, parallel and at right angles to the center line of the road-unless directed to be laid to an oblique pattern. The gap between the adjacent bricks shall not exceed 10mm. After laying each layer of bricks, interstices shall be filled with sand, moorum, grit or any other mineral matter with plasticity index not exceeding 6, so as to fill the gaps completely. The soling shall be sprinkled with water and rolled with a light roller. Weight of light roller shall be selected according to the nature of sub soil and strength of bricks used. On rolling, breakage of the bricks shall not exceed 5 per cent. Particular care shall be taken to use only sufficient quantity of water so as not to soften the sub grade.

19.17.5
Where brick soling is laid in two layers, top layer shall break joints with the bottom layer and each layer rolled and interstices filled to their full depth.

19.18 Rigid Pavement / PQC pavement

19.18.1 Mix proportion/and strength
Mix will be designed as per the design and the flexural strength shall not be less than specified value at 28 day in the field. The strength which is known as mean flexural strength shall depend upon quality control. The following relationship shall be used in calculating mean flexural strength.

\[
S = \frac{S}{S} \]

SIGNATURE OF TENDERER WITH SEAL  
EMPLOYER
Where

\[ S = \text{average strength at 28 days for which the mix is to be designed} \quad (\text{kg/} \text{sq.cm. or N/mm2 or MPa}) \text{ as specified.} \]

\[ S = \text{minimum (flexural) strength in the field at 28 days} \quad (\text{kg/} \text{sq.cm. or N/mm2 or MPa}) \text{ as specified.} \]

\[ t = \text{factor (dimensionless) depending on specified tolerance level as per table II} \]

\[ V = \text{co-efficient of variation (percent) specified as per table I (dimensionless percentage)} \]

**TABLE I VALUE OF COEFFICIENT OF VARIATION (PERCENT) “V” FOR DIFFERENT RANGES OF STRENGTH**

<table>
<thead>
<tr>
<th>Degree of quality control</th>
<th>Minimum specified flexural Strength (Kg/cm2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 40</td>
</tr>
<tr>
<td></td>
<td>Greater than 40</td>
</tr>
<tr>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Tolerance Level</td>
<td>Coefficient of variation “V”</td>
</tr>
<tr>
<td>1 in 15</td>
<td>1 in 15</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>1 in 20</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>1 in 40</td>
<td>15</td>
</tr>
<tr>
<td>2.23</td>
<td>10</td>
</tr>
<tr>
<td>2.76</td>
<td>10</td>
</tr>
<tr>
<td>1 in 100</td>
<td>15</td>
</tr>
<tr>
<td>2.63</td>
<td>10</td>
</tr>
</tbody>
</table>

**Note:**

1. **Very Good Quality Control**: Control with weight batching, use of graded aggregates, moisture determination of aggregates, etc. Rigid and constant supervision by the Quality Control Team.

2. **Good Quality Control**: Control with weight batching, use of graded aggregates, moisture determination of aggregates, etc. Constant supervision by Quality Control Team.

3. **Fair Quality Control**: Control with volume batching for aggregates. Occasional checking of aggregates moisture. Occasional supervision by Quality Control Team.

**TABLE II VALVESOF TOLERANCE FACTOR(t)**

<table>
<thead>
<tr>
<th>Tolerance level No. of samples</th>
<th>1 in 10</th>
<th>1 in 15</th>
<th>1 in 20</th>
<th>1 in 40</th>
<th>1 in 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.37</td>
<td>1.65</td>
<td>1.81</td>
<td>2.23</td>
<td>2.76</td>
</tr>
<tr>
<td>20</td>
<td>1.32</td>
<td>1.58</td>
<td>1.72</td>
<td>2.09</td>
<td>2.53</td>
</tr>
<tr>
<td>30</td>
<td>1.31</td>
<td>1.54</td>
<td>1.70</td>
<td>2.04</td>
<td>2.46</td>
</tr>
<tr>
<td>Infinite</td>
<td>1.28</td>
<td>1.50</td>
<td>1.64</td>
<td>1.96</td>
<td>2.33</td>
</tr>
</tbody>
</table>

19.18.2 Water Cement Ratio

The actual and designed quantity of water shall be used in the mix. The cement content shall be kept within a range of 350 Kg/cum to 425 Kg/cum only. The water cement ratio should invariably be kept between 0.39 to 0.42.

19.18.3 Trial Mix

Trial mix shall be made and beam tested for flexural strength as per requirement of IS 516-1 959. Nine sets of beams shall be tested, three for 7 days and three for 28 days. If the difference between the highest and lowest value at 28 days in any trial mix is more than 15% of strength of these beams, the test shall be discarded and further trial mix made. Crushing Strength of concrete shall be approved for the flexural strength.

19.18.4 Preparation of base

Before fixing the form work for laying concrete, the base shall be checked for proper compaction, density and levels.

19.18.5 Trial Bays
Before commencement of work and where as paver is not used, a trial bay of 305mx 305m and of same thickness as that of designed pavement shall be laid at an approved place. After laying the concrete, cores shall be taken out when concrete is 7 days old, to determine the degree of compaction achieved, should any of the cores show honey combing, the trial bay shall be re-laid. The method of compaction and spreading and also desired surface finish shall be approved.

19.18.6 Form Work
19.18.6.1 Steel Formwork
All side forms shall be of mild steel except for curves having radius less than 45 meters. The steel forms shall be of M.S. channel section and depth equal to thickness of pavement. A section shall have length of 3 metres except on curves of less than 45m radius, where shorter section or wooden formwork may be used. In case of transverse joints, a full length of the bulk head shall act as formwork. When set to grade and staked in place, no deviation of the top surface from the specified level shall be allowed. Use of bent, twisted or worn-out form shall not be permitted. The method of connection between the two length of forms shall be such that the joint formed is free from play or movement. Atleast three stakes for bracing pins or stakes shall be provided for each 3.00m of form and the bracing and support must be ample to prevent the springing of the forms under the pressure of the concrete or weight or thrust of machinery operation on the forms.

19.18.6.2 Wooden forms
Wooden forms shall normally be used only for curves having radii of less than 45m. Wooden forms shall be wrought on one side, these shall have minimum base width of 100 mm and depth equal to edge thickness of concrete. These forms, when specially permitted to be used on straights, shall have minimum length of 3.0m. Forms shall be held by stakes set at intervals not exceeding 2m, two stakes to be placed at each joint. The forms shall be firmly nailed or secured to the side stakes, and securely braced at pint where necessary so that no movement will result from the pressure of the concrete or the impact of the tamper and during finishing work. Wooden forms shall be capped along the inside upper edge with 50mm angle iron, well recessed and kept flush with the face of wooden forms.

19.18.6.3 Setting of Forms
The forms shall be jointed neatly. After the forms are placed and set the base of the forms shall be thoroughly tamped in an approved manner. All forms shall be cleaned and oiled each time before they are used. Forms shall be set, for at least one day's work ahead of concreting and shall remain in position for at least 12 hours after laying of concrete or longer as directed by the EIC. When forms have to be Deedon existing concrete bases they shall be secured at the side by M.S. stakes of 20 dia properly anchored into the base. Holes of suitable size for stakes shall be drilled at least 75 mm deep into the base and after the stakes are inserted they shall be properly wedged so that the stakes shall not get loosened during compaction of concrete. The trueness of form shall be checked by means of a 3m straight edge and any deviation greater than 1.5mm shall be rectified. No deviation from the straight edge shall be permitted at the joints.

19.18.7 Batching and Mixing
19.18.7.1 All the ingredients of concrete shall be batched by weight. Weigh batching shall be done with fully computerized weigh batching plant of minimum 30 cum / hour capacity (or as indicated). Where combined batching and mixing plants are not available, weigh batchers of adequate capacity shall be used for weighing of aggregates and cement. Power driven mechanical concrete mixers of adequate capacity in conjunction with weigh batches shall be used. A small quantity of water will be added before loading of aggregates and cement. The remaining water shall be added during the mixing operation. The mixing shall be done for at least two minutes and until a uniform colour and consistency is achieved. Quantity of concrete mixed in anyone batch shall not exceed the rated capacity of the mixer. The drum of the mixer shall be completely emptied before ingredients for the next mix are charged into it. Concrete mixed as above shall not be modified by addition of water or otherwise in order to facilitate handling or for any other purpose.

19.18.8 Placing and Compaction of Concrete
19.18.8.1 Concrete shall be transported without delay and incorporated in the works within 20 minutes from the time of discharge. The concrete shall be deposited and spread to such a depth that when compacted and finished, it shall conform to the grade and cross section specified in the plan to ensure the minimum slab thickness shown on the drawing to be obtained at all points.

In order to obtain adequate compaction, the concrete shall be spread so as to stand proud of the finished level and produce a surcharge. With screed and internal vibrator, slabs of thickness not exceeding 20 cm shall be laid in one layer. Where medium duty pavers are used, this limit shall be raised to 25 cm. Concrete for slabs of greater thickness shall be laid in two equal layers. The second layer shall be laid over the unfinished but compacted first layer within half an hour (within setting time of the cement used) of the laying of the first layer.

Concrete shall be deposited in such a manner as to require as little handling as possible. Spreading, compacting and finishing (except final completed belt finishing) operations shall be within a period not exceeding one hour from the time the mixing starts. In case of dry and hot weather, this time will not exceed 35 minutes. Concrete shall be placed around man-holes or other structures after these have been brought to the correct alignment.

19.18.8.2 Compaction of concrete
Compaction shall be carried out by electrically operated needle and screed vibrators as stipulated hereafter. Needle vibrators shall be used all over the area for obtaining initial compaction of concrete. These shall be of diameter not less than 4.5 cm. If the vibrators are pneumatic, the pressure must not be below 4 Kg/cm². If electrically operated they shall have a minimum frequency of 3500 impulses per minute. Minimum number of petrol driven vibrators as specified by the EIC with minimum frequency of 3500 per minute shall be provided at each work head as a stand by arrangement. The screed and internal vibrator shall conform to IS. 2506-1985 respectively.

Vibrating screed consisting of a steel section or timber section weighing not less than 1.5 Kgs per metre with a tamping edge of not less than 7 cm. width and having a vibrator mounted there on shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with an M.S. plate to be rigidly fixed by means of counter sunk screws. Where screed vibrators are used for compaction, at the discretion of the EIC for compaction of edges and joints, vibrators may be supplemented by hand tamping and Roding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

When using vibrating screed for compaction it shall not be dragged over the concrete. During the initial passes, it shall be lifted to the adjacent forward position in short steps. Subsequently, it shall be slowly slid over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained. Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints.

Concrete shall be deposited on the base as near the forms as possible without touching them. It shall then be shoveled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of forms, care being taken that it is worked well around the forms. The concrete shall not be dumped from the bucket directly upon or against the forms.

Workmen shall not be allowed to walk on freshly laid concrete. All operations shall be carried out from suitable wooden bridges spanning the lane.

19.18.9. Use of Pavers
The contractor shall use slip from/ fixed form paver as indicated for depositing, consolidation & finishing of concrete pavement. The paver(s) shall be of adequate capacity and suitable width of work bridge so as to complete concrete pavement within stipulated/ agreed period of completion.

19.18.10. Joints in Concrete Pavement (using sealing compound)
19.18.10.1 General

Joints shall be of the types and dimensions as indicated and shall be located as indicated.

19.18.10.2 Dummy Joints

The dummy joints shall be 10 mm wide and shall extend vertically from the surface of the slab to a depth equal to 1/3 to 1/4 of the thickness of the slab. The joint may be formed by depressing into the soft but compacted concrete a high tensile mild steel. ‘Tee’ or flat bar of depth not less than the required depth of the joint plus 25 mm. The bar used for forming the groove shall be coated with soft seal or other suitable lubricant and have built in handles rigidly fixed to facilitate its removal without spalling or crumbling the edges. When the steel bar is removed, joints shall be nearly reformed immediately with proper tools and with mortar/fine material from the slab itself. No additional cement mortar shall be used. Alternatively the slot may be formed by sawing the concrete with a joint cutting machine (diamond cutter) of approved design within 6 hours of placing under moderate climatic conditions and when the concrete has sufficiently hardened. Under extreme cold conditions, this period may be suitably increased based on experience. In all cases, except where cutting is done with saw, the joint edges shall be bull nosed. Care shall be taken that the edges of the joints are not damaged. The edge shall not stand proud of the concrete slabs.

19.18.10.3 Construction Joints

The construction joints shall be 10mm wide and straight and vertical though the full thickness of the slab. The vertical edge of the concrete on the side of the joint shall be treated with a coat of lime wash or bituminous paint before the adjacent bay is concreted. A groove 2.5 cm deep and 1 cm wide shall be formed at the top surface of the joint to receive the sealing compound. The groove shall be formed in the same manner as that for a dummy joint. The edges of the groove shall be bull-nosed and not stand proud of the concrete surface.

19.18.10.4 Expansion Joints

The expansion joints shall be straight and shall extend through the full thickness of the slab and shall be of the shape and dimensions shown on the drawings. The slab edges adjacent to the joint shall be formed truly vertical. The joints shall be filled with a 2.5 cm thick filler board. Hot applied joint sealant (Grade A) will be used as joint sealant. The groove to receive the sealing compound may be formed by cutting the extra filler board to the required depth.

19.18.10.5 Sealing of Joints

19.18.10.5.1 All joints shall be sealed as soon as practicable after 28 days of placing of the slabs. The joints shall be finished flush with the finished concrete surface if the sealing of joints is done in summer and 3mm below the finished concrete surface, if the sealing of joints is done in winter. After the sealing compound has hardened, the excess sealing compound, if any, adhering to the slab outside the joints shall be removed by scraping or otherwise and the surface left clean. The pavement shall be opened to traffic only after the completion of joint sealing over the entire pavement.

19.18.10.5.2 Cleaning of Joints

All foreign materials in the joints shall be removed with pneumatic blower. The joints shall, thereafter, be cleaned with a coir brush. Fine particles clinging to the concrete faces shall be removed with the help of an air compressor only to avoid damage to the edges. The joints shall be cleaned and surface dried before the application of primer.

19.18.10.5.3 Application of Primer

The cleaned joint shall be primed with a 20-25mm side painter’s brush, while painting, light pressure shall be applied so that the primer penetrates into the pores of concrete. The primer shall be applied twice on one side (i.e. by forward and reverse movement of brush). The primer shall be applied in
19.18.10.5.4 Sealant joints

Only hot applied grade ‘A’ joint sealant of approved make will be used in rigid pavements. While the joints shall be sealed flush with the adjacent pavement surface in summer, in winter they shall be filled to a depth of 3-4mm below the surface. This procedure will reduce the possibility of ingress of grit and other foreign matter into the sealing compound as well as dislodging of the hardened sealing compound under traffic.

19.18.11. Joints in pavement concrete, (using Grade A joint sealant as per IS 1834)

19.18.11.1 General

Joint shall be of the types and dimensions specified and are located in all as directed by EIC. The edges of the groove/joints shall be bull nosed & not stand proud of the concrete surface.

19.18.11.2 Dummy Joints

19.18.11.2.1 The size of joints shall be as indicated/ specified as per drawing.

19.18.11.2.2 The joint shall be formed using mechanical equipment (diamond cutter) within 6 hour of placing of concrete under moderate climatic conditions and when the concrete has sufficiently hardened. Cutting or sawing by a sawing mounted at movable frame and driven mechanically will also be permitted as a method for making the joint. Care shall be taken that the edges of the joints are not damaged.

19.18.11.2.3 In case of sudden rain or storm, the work can be concluded at the dummy joint but the latter will then be formed into a construction joint.

19.18.11.3 Construction Joints

19.18.11.3.1 Construction joints shall also be provided at places where concreting is stopped due to unforeseen circumstances. The size of joints shall be as specified and as shown on drawings.

19.18.11.3.2 Construction joints shall be straight and vertical through the full thickness of the slab. The vertical edge of the concrete of the side of the joint shall be treated with a coat of lime wash or bituminous paint before the adjacent bay is concreted. A groove of dimension as specified in drawing shall be formed. The groove shall be formed in the same manner as that for a dummy joint.

19.18.11.4 Expansion Joints

20. B.7.1 1.4.1 The expansion joints shall consist of a joint filler board as detailed in the drawing. The depth of the filler board shall be cut by 25mm from top to prepare the joint.

19.18.11.4.2 Joints shall be straight and shall extend through the full thickness of the slab and shall be of the shape and dimensions shown on the drawings. The slab edge adjacent to the joint shall be formed truly vertical. The joints shall be filled with approved joint filler as per clause 19.18.10.4.

19.18.11.4.3 Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with the approved primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape. Bond breaker tape shall be applied on the top face of the pad before inserting the dosed cell backup rod. It shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The faces of the pad against which the new concrete slab is to be laid shall also be painted with the approved primer before laying the concrete. While concreting a neat groove as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
19.18.11.4.4 The groove to receive the sealant may be formed by cutting the excess filler board material to the required depth.

19.18.11.4.5 Expansion joints shall be provided both longitudinally and transverse direction at spacing as shown on drawing or as directed by Engineer-in-Charge.

19.18.11.5.1 CONSTRUCTION PROCEDURE

19.18.11.5.1 Expansion joints shall be provided as shown in the drawing and as per directions of Engineer-in-Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. The joint shall be 25 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab.

19.18.11.5.2 Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

19.18.11.5.3 Before the curing process is started, the top of expansion joint shall be filled with bitumen sandmixture in order to ensure that no foreign material used in curing enters into the joint. This filling shall be removed before filling the joints with sealing compound.

19.18.11.5.3.1 For sealing the joints following operations shall be carried out:

(a) The joints are cleared of any foreign matter to the full depth upto the top of expansion pad with steel spatula.

(b) The joints are blown with compressed air.

(c) Cleaning is done with Kerosene oil.

(d) Priming is done with spray gun @ 2.6 liters per 10 sqm of the surface to be primed.

(e) The primer is allowed to dry completely before pouring the sealing compound.

(f) The sealing compound grade 'A' is heated to the required temperature ranging between 155 deg. C to 165 deg. C or to the temperature range specified by the manufacturer. Over heating shall be avoided. Pouring shall be done from vessel with spout in such a manner that the material will not get spilled on the exposed surface of the concrete, any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned.

(g) The filling shall be worked into the joints with hot flats to ensure escape of trapped air.

(h) The filling is then ironed with hot iron. It is recommended that while in summer the joints may be sealed flush with the adjacent pavement surface, in winter the sealing compound may be filled to a depth 3-4 mm below the surface.

(i) The edges of the joints are then cut and trimmed to ensure neat and straight line finish.

0) To prevent tackiness or pick up under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge (Nothing extra shall be paid for the same).
19.18.11.53.2 Precautions

(a) Some people are sensitive to resins, hardeners, vapour etc. Therefore it is advisable to use hand gloves/ goggles and suitable protective clothing.
(b) Avoid application below 10°C temperature.
(c) Avoid application on damp or moist surfaces.
(d) Do not expose primer to naked flames or other sources of ignition.
(e) Materials to be kept in no smoking area.
(f) Containers should be tightly sealed when not in use.
(g) In the event of fire, extinguish with carbon dioxide or foam.
(h) Should accident skin contact occurs, remove immediately with a resin removing cream, followed by soap and water. Do not use solvent.
(i) In case of contact with eyes, rinse immediately with plenty of clean water and seek medical advice.
(j) Use only in well ventilated areas.
(k) All consumables (masking tape, empty cartridges etc) should be removed and disposed off safely.

19.18.12 Finishing of Concrete

19.18.12.1 Straight Edging

Immediately after the compaction of concrete and the construction of joints but before the concrete has hardened and while the concrete is still in plastic state, the pavement surface shall be inspected for irregularities with a profile checking template and any needed correction made by adding or removing concrete by means of long handled floats and scraping straight edge followed by further compaction and finishing. The long handled floats may be used to smoothen and fill in open textured areas in the pavement surface but the final finishing is to be made with scraping straight edges.

The scraping straight edges are to be 3 metres long with flexible long enough to reach the other side of slab when operated from one side of the pavement. They are to be placed parallel to the forms at the side of the pavements and worked backwards and forward uniformly across the width of the slab. After this operation has been completed and the surface shall be brought to the required finish, the straight edges shall be moved forward by not more than half their length and this process repeated.

The straight edge testing and re-floating shall continue until entire surfaces:-

(a) are free from observable departure from the straight edge;
(b) conforms to the required levels and cross section; and
(c) when the concrete has hardened, it shall conform to the specified surface levels.

The foregoing work shall be carried out while the concrete is still plastic and workable and in such time sequence as to ensure the removal of water of laitance from the surface.

After the concrete has sufficiently hardened to about 12 hours and not later than 24 hours, the surface shall be tested again for high spots shall be marked and those exceeding 3 mm shall be ground down immediately. Care shall be taken to ensure that the grinding does not in any way damage the concrete surface. The final surface finish is to be such that when tested with 3 metres long straight edge placed any where within the same or adjoining slab in any direction on the surface there is no gap greater than 3 mm between the bottom of the straight edge of the surface of the pavement.

19.18.12.2 Belting

Just before the concrete becomes non-plastic the surface shall be belted with a two-ply canvas belt not less than 20 cm wide and at least 1 metre longer than the width of the slab. Hand belt shall have suitable handles to permit controlled uniform manipulation. The belt shall be operated with short strokes transverse to entire line of pavement and with a rapid advance parallel to the centre line.

19.18.12.3 Brooming

After belting and as soon as surplus water, if any, has arisen to the surface the pavement shall be
given. A broom finish with an approved steel or fibre broom not less than 45 cm wide. The broom shall be pulled gently transversely and in straight strokes over the surface of pavement from edge to edge. Adjacent strokes shall be slightly over-lapped. Brooming shall be perpendicular to the centre line of the pavement and so, executed that the corrugations thus produced will be uniform in character and width, and not more than 1.5 mm deep. No pressure will be applied to be broom and scoring shall be done under the weight of broom head without tearing the surface.

Brooming shall be completed before the concrete reaches such a state that the surface is likely to be tom or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions, and pot-holes such as may be caused by accidental disturbing of particles of coarse aggregate embedded near the surface.

19.18.12.4 Edging

Immediately after belting/brooming has been completed, the edges of the slab shall be carefully finished with an edging tool of 6 mm radius and the pavement edges shall be left smooth and true to line.

19.18.12.5 Honey combing

As soon as the side forms are removed minor honey combed areas shall be filled with mortar composed of one part of cement to two parts of fine aggregate. Major honey-combed areas or segregated concrete or other defective work or areas damaged by the removal of the forms or concrete damaged by rain or any other reasons shall be removed an replaced. The total area of honey-combed surface more than 2.5 sq.cm, each shall not exceed 4% of the area of the slab side. Honey-combing exceeding 300 cm2 in area at anyone location shall be considered as major honey-combing.

Every slab shall bear an impression not exceeding 3 mm in depth comprising the number allotted to the slab and the date on which it was laid. The impression shall be formed when the concrete is green so as to leave permanent mark of setting.

19.18.13 Curing and Protection of Concrete

19.18.13.1 Initial Curing

The initial curing shall be done by spraying with liquid curing compound. The curing compound shall be white pigmented or transparent type with water retention index of 90 per cent when tested in accordance with BS 7542. Curing compound shall be sprayed immediately after rolling is complete. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days. Application process as per manufacturer’s specifications and contractor should submit the technical literature & get approval from the EIC and the material should be used within the shelf time.

19.18.14.1 Testing of pavement concrete

19.18.14.1 Testing of pavement concrete shall be in accordance with relevant IS Specifications.

19.18.14.2 7-day strength

The concrete mix should be prepared for the flexural strength given in the design and will be tested on 28 days strength. However the 7 days strength gives an early indication of the strength likely to be achieved. 7-days strength shall be determined at least 8 to 10 days prior to laying of concrete. At least 3 beams should be casted and tested for flexural strength as per IS : 516 of 1959. The strength achieved should be 75%of the 28 days strength. If it is less, then the concrete mix should be re-designed and re-tested. After the laying of concrete starts, determination of 7-day strength is not necessary.

19.18.14.3 28 -days Strength

At least 3 beams for every slab (100 ft x 12.5 ft x 1 ft) will be casted and tested for flexural strength as per IS : 516 of 1959. The concrete mix should be prepared for the flexural strength given in the design. After at least 30 samples have been cast for slab laid in similar conditions their results should be tabulated and LCL determined as follows:
LCL = X - tv where

X = Mean flexural strength from the samples tested,

\( \text{t} = \) Tolerance level factor,

\( v = \) Standard deviation of the samples tested.

LCL so determined should not be less than specified value. Along with the beams, cubes will also be cast and tested for compression as IS: 516 of 1959. The compressive strength will be tabulated along with the corresponding flexural strength to establish correlation between flexural and compressive strength.

19.18.14.4 Workability

Compacting factor tests and slump tests should be carried out as per IS: 1199 of 1959. In case concrete is being machine-laid, then only compacting factor tests should be carried out otherwise whether of the two can be carried out at the discretion of the EIC. Compacting factor/slump tests shall be carried out for every 10 cu.m of concrete mixed. The concrete shall not be laid unless the appropriate test has been carried out and authority given for start of laying. Any batch of concrete giving a compacting factor or slump which does not comply with the laid down value (± 0.02 in case of compacting factor only) shall be rejected and removed from the site.

19.18.14.5 Acceptance of concrete

Concrete shall only be accepted if it satisfies the following main conditions:

(i) LCL of every lot (atleast 30 samples) is not less than specified value,
(ii) Co-efficient of variation is not greater than 10%.
(iii) Tolerance Level Factor is 1.5.
(iv) There is no honey-combing in the concrete.

19.18.14.6 Critical Examination of Test Data

In case LCL of a lot is less, then the following procedure shall be adopted before core tests are undertaken:

(i) Omit the slab having lowest average strength and revaluate the remaining test date of the samples.
(ii) If the revaluated data conforms to the above acceptance criteria, accept the lot less the slab omitted. (iii) In case of unsatisfactory result, repeat the process by omitting the next lowest till all weak slabs are segregated for further testing by core cutting and the part lot gets specified value.

19.18.14.7 Core Tests

In case the concrete fails in flexure test i.e. the LCL is less than specified for a particular lot, then concrete shall not be rejected unless it also fails in core test. In core test, atleast two cores of the same will be cut per slab. The crushing strength of this core is then determined. The crushing strength should not be less than 0.8 times the corresponding crushing strength of 15 cm cubes. The crushing strength determination will be as per IS: 516 of 1959. In case the L/D ratio of the core is between 1 and 2, then the crushing strength of the cube will be reduced. The correction will be carried out as per the formula given below

\[ F = 0.11n + 0.78 \]

Where \( F = \) Correction factor \( L \)

\( n = -L/D \) ratio \( (L' \) and \( D' \) are height and Diameter respectively

In case the concrete fails the flexure (LCL) test, but is found satisfactory in core test, it shall be accepted as the core test takes the precedence over the flexure test. However, in case the concrete fails both flexure as well as core test, then it shall be rejected and replaced.

19.18.14.8 All holes from which cores have been cut, will be filled with the same concrete from which the original slab was laid i.e., concrete of the same design mix.

19.18.15 Quality Control
## 19.18.15.1 The following quality control tests shall be carried out at frequencies specified against each during progress of work:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Test</th>
<th>Test Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Coarse Aggregates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Flakiness Index</td>
<td>IS: 2386 (Part – 1)</td>
<td>one test for every 100 Cum of aggregates.</td>
</tr>
<tr>
<td></td>
<td>(b) Impact Value</td>
<td>IS: 2386 (Part-4)</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>(c) Los Angeles Abrasion Value</td>
<td>IS: 2386 (Part 4)</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>(d) Deleterious Materials</td>
<td>IS: 2386 (Part-2)</td>
<td>Before approval of the quarry and at every subsequent change in the source of supply.</td>
</tr>
<tr>
<td></td>
<td>(e) Moisture content</td>
<td>IS: 2386 (Part-3)</td>
<td>Minimum of two test per day for correcting the water demand of the mix.</td>
</tr>
<tr>
<td></td>
<td>(f) Soundness</td>
<td>IS: 2386 (Part-5)</td>
<td>Before approving the aggregates and every month subsequently</td>
</tr>
<tr>
<td></td>
<td>(g) Alkali aggregate reactivity</td>
<td>IS: 2386 (Part-7)</td>
<td>-do-</td>
</tr>
<tr>
<td>2</td>
<td><strong>Fine Aggregates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Silt Content</td>
<td>IS: 2386 (part – 1)</td>
<td>One test per 250 Cum.</td>
</tr>
<tr>
<td></td>
<td>(b) Gradation of sand,</td>
<td>IS: 2386 (part – 1)</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>© Deleterious materials</td>
<td>IS: 2386 (part – 2)</td>
<td>Before approval of the quarry and at every subsequent change in the source of supply.</td>
</tr>
<tr>
<td></td>
<td>(d) Moisture content</td>
<td>IS: 2386 (part – 3)</td>
<td>Regularly for correcting the water demand of the mix on daily basis.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Cement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical and chemical test</td>
<td>IS: 269, IS:455, IS:1489, IS:8112, IS:12269</td>
<td>Once for each source of supply and occasionally when called for in case of long/improper storage. Besides the contractor also will submit daily test data on cement released by the manufacturer.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Water</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical tests</td>
<td>IS: 456</td>
<td>At approval of source of supply, subsequently at interval of three months.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Mixed Aggregates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grading</td>
<td>IS: 2386 (Part-1)</td>
<td>1 test per 150 Cum.</td>
</tr>
<tr>
<td>6</td>
<td><strong>Concrete</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Slump test</td>
<td>IS: 1199</td>
<td>One test per each dumper load at both batching plant site and paving site initially when works starts. Subsequently sampling may be done from alternate dumper.</td>
</tr>
<tr>
<td></td>
<td>(b) Flexural strength of concrete</td>
<td>IS: 516</td>
<td>One test consisting of nine works test beam for every 150 cum of concrete. Three of the beams shall be tested at 7 day and three ar 28 days for flexural strength, The remaining three beams shall be kept as reserve exclusive for government use for subsequent testing (if so desired by Government) and preserved for one year from completion of</td>
</tr>
</tbody>
</table>
(c) Core strength on hardened concrete

**IS:516**

In case of doubt or in case of lab test not found satisfactory.

(d) Thickness determination

From the level data of concrete pavement surface and sub base at grid points of 5/6.25m x 3.5m

(e) Thickness measurement for trial

3 cores per trial length

(f) Verification of level of string line in the case of slip form paving and steel forms in the case of fixed form paving

String line or steel from shall be checked for level at an interval of 5.0m or 6.25m. The level of tolerance allowed shall be ± 2mm. These shall be got approved 1-2 hours before the commencement of the concreting activity.

---

**19.18.15.2** Quality control test for levels alignments and texture shall be carried out as under:-

(i) Level tolerance

+ 5mm

(ii) Width of pavement and position of Paving edges

± 10mm

(iii) Pavement thickness

- 5mm to +25mm

iv) Alignment of joints, widths, depth of To be checked @one joint per 400m length or a day’s work whichever is more.

(v) Surface regularly both transversely Once a day or one day's work, without and longitudinally disturbing the curing operation.

(vi) Texture depth:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Time of Test</th>
<th>Number of measurements</th>
<th>Required Texture depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Special Value</td>
</tr>
<tr>
<td>(a)</td>
<td>Between 24 hours and 7 days after the construction of the slab until the slab is first used by vehicles.</td>
<td>An average of 5 measurements</td>
<td>1.00mm</td>
</tr>
<tr>
<td>(b)</td>
<td>Not later than 6 weeks</td>
<td>An average of 5 measurements</td>
<td>1.00mm</td>
</tr>
</tbody>
</table>

**19.19 Precast Interlocking Paver blocks**

Precast concrete Paver blocks shall conform to IS 15658:2006. Specification for Precast concrete blocks for paving. Paver blocks shall be sound and free from cracks or other visual defects. The tolerance on length or breadth of paver blocks shall be +2mm and tolerance on thickness of tiles shall be +3mm. Water absorption shall not be more than 6 percent by mass. Shapes shall be triangular, Zigzag, Hexagon or other shape as indicated. Colour of paver blocks shall be as indicated or as decided by GE. Thickness and grade of concrete of paver blocks is decided based on intensity of traffic, which is as under (Refer Table 1 of IS 15658):

<table>
<thead>
<tr>
<th>Traffic Category</th>
<th>Paver block Thickness</th>
<th>Grade of concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Traffic</td>
<td>60mm</td>
<td>M-35</td>
</tr>
<tr>
<td>Medium Traffic</td>
<td>80mm</td>
<td>M-40</td>
</tr>
<tr>
<td>Heavy Traffic</td>
<td>100mm</td>
<td>M-50</td>
</tr>
</tbody>
</table>
19.20 PRECAST KERB STONE

19.20.1 Laying

19.20.1.1 Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cementmortar of specified proportion.

19.20.1.2 The kerb stones with top 12.50 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones with top 30 cm. wide shall be laid in position in chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement: 3 coarse sand) and pointed with mortar 1:2(1 cement: 2 fine sand) which shall be cured for 7 days.

19.20.1.3 The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer-in-Charge for connecting to storm water drains.

19.20.2 Finishing

Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed off as directed by the Engineer-in-charge. Nothing extra shall be paid for this.

19.20.3 Measurements

It shall be measured in cubic meters with Length of the finished work (for specified width and height of stone) shall be measured in running metre along the edge of the road correct to a cm.

19.20.4 Rate

The rate shall include the cost of all the materials and labour involved in all the operations Described above.

19.21. Admixtures (For use in quality concrete)

Admixtures conforming to IS : 6925 and 15:9103 shall be permitted for use to improve workability of the concrete or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability.

SECTION -20

CLEAN ROOM WORKS

Scope of Work:

The scope of works under this contract includes (but not limit to) engineering, manufacture, supply, installation, testing, protecting, guarantees and maintenance upto the defects liability period.

The work under this section includes all labour, materials, equipment and services as required for the complete, engineering, fabrication, assembly, delivery, anchorage, installation, developing a leak proof Clean room of Class-100000.

An engineering report demonstrating, by means of calculations, drawings, test reports, etc. shall be submitted by the contractor.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Building regulations:

Erection of the structure/system based on concepts / drawings issued shall comply with reference to relevant Clean room codes and regulations.

Guarantee:

The contractor shall be fully responsible for and shall guarantee in an approved format proper erection and performance of his installed systems for a **defect liability period** from handing over of works. The installation shall be to the best international standards.

**Contractor’s responsibilities:**

The Contractor’s responsibilities includes but are not necessarily limited to the following items:

a) The contractor shall provide and install all supplementary parts and incidentals, necessary to complete all items generally implied in the drawings and in the specification though not specifically shown or mentioned. This shall include the sizing of all sections and anchor assemblies to meet the performance and design requirements, furnishing and installation of all inserts, fasteners, clips, bracing and framework as required for the proper anchorage to the structure, unless otherwise noted specified to be furnished / installed by another contractor. Alternate anchorage proposals will be considered, if, in the opinion of the Engineer-in-charge the general design and intent of the drawings and specifications are maintained. The Contractor’s system therefore must perform satisfactorily as a whole.

Protection:

The Contractor shall protect the CLEAN ROOM due to ongoing works at site and other incidentals in a method acceptable to Engineer-in-charge. A method statement of the CLEAN ROOM system shall be submitted and approved by Engineer-in-charge. Also contractor shall take all necessary precaution, as may be required/ directed, during execution of the works to minimize any hindrance of the other ongoing works.

Tests and Standards:

The contractor shall provide tested materials for the CLEAN ROOM system. The Contractor shall provide necessary test certificates from the manufacturers for all the materials, components and system that are to be incorporated in the works along with the supplies, Engineer reserves the right to witness any of the tests at Contractor’s cost.

Materials:

The contractor shall use best quality materials, hardware etc. for manufacturing of CLEAN ROOM and other items.

Shop Drawings:

The contractor shall prepare shop drawings by necessary modifications to the preliminary drawings and two (2) copies of all shop drawings shall be submitted to the Engineer-in-charge for review and approval. The Engineer’s review of all shop drawings will be limited to their conformity to the design concept & specifications. Engineer’s approval of the shop drawings will not relieve the contractor from any for the responsibilities and requirements. Shop drawings shall incorporate scaled and dimensioned plans, elevations, sections and full size details for all work in this section. Shop drawings shall indicate the desired dimensional profiles and modules, function, design and performance standards and, in general delineate the scope of work. The contract drawings and specification. Since the dimensions and modular references shown on the drawings are for specific and / or typical detail, the shop drawings all metal sections, types of finishes; areas to be sealed and sealant materials; of all applicable construction including fasteners and welds; all anchorage assemblies and components; the fabrication and erection tolerances for the work and applicable related works adjoining, attached to or in some way related to the work covered by these specifications. The location of all static and dynamic movements, co-ordination with concrete works and the sequence of installation shall be designated on the applicable plans, elevations and / or sections. All details shall be subject to Engineer's approval. Shop drawings shall indicate the desired profiles, dimensions, details of metal finish and in general delineate the scope of work. Profile adjustments in the interest of fabrication, erection, weather ability or ability to satisfy the performance requirements may be made only with the written approval of the Engineer-in-charge, provided that the general design and intent of the drawings...
Samples:

Samples of actual job site materials together with detailed technical data/catalogues shall be submitted in duplicate, unless otherwise noted, and in the sizes noted, for Engineer’s review and approval.

Provision for a various utility:

The Contractor shall keep provision for electrical light fittings, ducts, vision panels etc., while installing the structure for CLEAN ROOM.

The items proposed are mentioned below:

20.1 100mm / 50mm thick Wall Panels:
- Double skin modular panels made of 0.8 mm thick powder coated Galvanized Plain Skin Passed sheets on both side with Poly Urethane Foam (40kg/m3 density) as infill.
- Cold roll formed galvanized profiles for reinforcing the two skins along the periphery and along the cut out lines where ever cut outs are provided.
- Clamps for locating and fixing the wall panels.
- U-Factors for 100mm Panel is 0.17
- U-Factors for ceiling Panel is 0.15
- Galvanized floor profiles with level adjustment up to 20 mm.
- Floor track suitable to accommodate coving.
- Wall cut outs shall be factory made cutouts.
- In built return air raisers in wall panel of 100mm thickness in Galvanized Iron Powder Coated.
- Providing and fixing of MS conduit 25 or 20 mm in the wall panels.

Minimum thickness of epoxy powder coating shall be 55 micron.

Mode of Measurement:

The area of Wall panel shall be measured in Square Metre. The area for payment shall be worked out correct up to two places of decimals of a square meter.

Cut out made in the wall panel shall be measured in numbers.

MS conduits provided in the panels shall be measured in running metre.

100mm wide In built air returns shall be measured in Square metre of laid area (Perimeter)

The rate includes for:

1. All necessary labour, materials, transportations and use of tools.
2. Finishing the cutouts with required aluminum sheet, painting to match the adjacent surface, finishing and making leak proof joint with sealant etc.,
3. Required material and Painting to match the wall / ceiling panel surface, where ever cutout provided
4. Stiffeners for in built air returns

20.2 Ceiling Panels and Blank Panel:
- 40 mm thick double skin walk able false ceiling shall be of Non-progressive construction.
- 0.8 mm thick powder coated Galvanized Plain Skin passed sheets on both sides with Polyurethane Foam (40kg/m³ density) as infill.
- U-Factors for ceiling Panels is 0.12
- Supporting GI hardware like turn buckle, threaded rods & other hardware.
- All the suspension material in Galvanized finish.
- Wall cut outs shall be factory made cutouts
- In built return air raisers in wall panel of 100mm thickness in GIPC
- MS conduit 25 or 20 mm in the wall panels
- Return air grills

**Mode of Measurement:**

The area of Ceiling panel shall be measured in Square Meter. The area for payment shall be worked out correct up to two places of decimals of a square meter.

Cut out made in the Ceiling panel shall be measured in numbers.

MS conduits provided in the panels shall be measured in running metre.

100mm wide In built air returns shall be measured in Square metre of laid area.

Return air grills are measured in Square metre.

The rate includes for:

1. All necessary labour, materials, transportations and use of tools.
2. Finishing the cutouts with required aluminum sheet, painting to match the adjacent surface, finishing and making leak proof joint with sealant etc.,

3. Required material and Painting to match the wall / ceiling panel surface, where ever cutout provided.

4. Stiffeners for in built air returns

**20.3 Vision Panel:**

- Clear Vision Glass of 6 mm thick shall be provided
- Clear Vision Glass shall be fixed flush to both faces of the door / wall panels to provide ease of Cleaning and maintenance.
- No crevices / joints / sloped profiles are used for fixing the glass to avoid particle contamination and dust accumulation.

**Mode of Measurement:**

The area of Vision Panel of one side shall be measured in Square Metre for the exposed surfaces of Vision panel between frames. The area for payment shall be worked out correct up to two places of decimals of a square meter.

The rate includes for:

1. All necessary labour, materials, transportations and use of tools.

**20.4 Air Shower**

**Description**

Air shower enclosure to be used for removing surface particles from personnel prior to entering a controlled environmental area. The air shower shall provide access to and from a clean room work area and shall be a high velocity, low air pressure system.

**Contact parts /Material of Construction**

- **Body structure** - SS 304 with No.:4 Finish
- **Enclosure** - Prefabricated wall and roof sections with integral air duct plenums
Components used: The Air Shower consists of below mentioned items
- HEPA filter, and electrical controls. Switch for UV light and Florescent On/Off
- Hour meter for UV is provided.
- Door interlocking is provided with Electromagnetic type.
- Doors are provided with double glazed view panel.
- Compact Fluorescent light with Acrylic diffuser.

Mode of measurement:
The measurement shall be for each unit of Air Shower. The quoted rate shall be including all the components mentioned in above paragraphs.

Mode of payment:
The contract rate shall be for each unit of Air Shower

20.5 Doors:

MATERIAL
Door Frames and Leaves are made from Galvanized Steel.

DOOR LEAVES
46mm thick metal swing type door, Constructed from 0.80mm Thick Galvanized Steel Sheet formed to provide a 46mm thick fully flush, double skin door shell with Lock Seam joints at stile edges. The surface shall painted with 90 microns or thermosetting polyurethane paint of aliphatic grade providing high levels of scratch resistance & durability. In-fill between sheet, Polyurethane foam (density 40kg/cum) is used to give the required rigidity and effective acoustic and thermal insulation.

DOOR FRAMES
Produced from 1.20mm (18G) thick galvanized steel sheet formed to single rebate profile of size 100mm X 57mm. In-fill of Polyurethane foam (density 40kg/Cum) is used to give the required rigidity. The painting shall be same as on door leaves.
The Door Frames may be built into the walls panels

VISION GLASS
Rectangular Vision Glass of 6 mm thick can be provided in various sizes depending on end users requirements such as 200mm X 300mm, 350mm X 750mm & 450 X 750 mm. The Vision Glass shall be fixed flush to both faces of the door to provide ease of cleaning and maintenance. No crevices / joints / sloped profiles are used for fixing the glass thus avoiding particle contamination and dust accumulation.

LIMITATIONS ON VISION GLASS (FOR NON STANDARD SIZES):
Height not exceeding 750mm, Width not exceeding 450mm, however, the vision glass width shall be 300mm less than that of the shutter width.
FINISH
The door frames and door shutters are finished with epoxy powder coated paint (60 microns) of providing high levels of scratch resistance and durability which is also of Anti-static quality.

IRONMONGERY
Hinges
SS Ball bearing butt Hinges 3 MM thick (3 numbers or More), fixed flushed to the frame and shutter.

LOCK
Mortise Sash Lock with Lever Handles, Mortise Dead Bolt, Mortise Latch, Panic Devices etc

FLUSH BOLTS (DOUBLE DOOR)
Concealed extended lever action flush bolts provided on the top of the door to the leading stile edge.

DOOR CLOSERS
Doors are made suitable to receive a large variety of Door Closers (Dorma T71).

SIGNATURE OF TENDERER WITH SEAL

ADDITIONAL ACCESSORIES
Electro Magnetic Hold Open Device, Smoke Seals for Air tightness, Automatic Door Bottoms etc., can be provided if required.
The rate for shutters shall include:
- Cost of supply, assembly and erecting in position.
- Cost of labour for making adjustments in frames, if required, shutters and also for fixing required fittings and fixtures mentioned in above paragraph.

The rate for individual item mentioned in the schedule of quantities shall include cost of shutters, labour for provision of glass for vision panel, hardware fittings mentioned in the ironmongery heading, transporting charges and labour for fixing of fixtures and fastening fixing of door closers and painting and polishing to match the wall panel surface as specified.

20.8 Coving:
1) Extruded aluminum powder coated clip-on type covings for, wall to wall & wall to ceiling joints. The epoxy powder coating shall be of 60 micron
2) Extruded aluminum double cove integrated with top track of the partition panels. The epoxy powder coating shall be of 60 micron
3) Three corner internal & external cove joining pieces in aluminum powder coated finish. The epoxy powder coating shall be of 60 micron

Mode of measurements:
- For Item No.20.8 (1) above Extruded aluminum powder coated clip-on type covings shall be measured in running meter. The linear dimensions shall be measured up to two places of decimals of a meter.
- For Item No.20.8 (2) Extruded aluminum double cove type covings shall be measured in running meter. The linear dimensions shall be measured up to two places of decimals of a meter.
- For Item No.20.8 (3) Three internal & external cove joining pieces shall be measured in each. The above items rate include cost of labour, over laps, all material, hardware fittings for fixing, tools & tackles etc.,

SECTION -21

HORTICULTURE AND LAND SCAPING

21.0 HORTICULTURE WORK

Horticultural operations shall be started on ground previously levelled and dressed to required formation levels and slopes. In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth.

In the course of excavation or trenching during horticultural operations, any wails, foundations, etc met with shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge.

21.1 TRENCHING IN ORDINARY SOIL

21.1.0 Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc and to bring up the lower layer of good earth to form a proper medium for grassing, re grassing, hedging and shrubbery. Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for re grassing in good soil.

21.1.1 The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.

21.1.2 Weeds or other vegetation which appear on the ground are then uprooted and removed and

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
21.1.1.1 Trenching

Trenching shall consist of the following operations:

The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge

These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.

In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.

The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

21.1.4 Measurements

Length and breadth of the plot shall be taken correct to cm and depths correct to cm. Cubical contents shall be calculated in cubic meters, correct to two places of decimal. No deduction shall be made nor extra paid for removing stones, brick bats and other foreign matter met with during excavation up to initial lead of 50 m and stacking the same.

21.1.4 Rate

The rate shall include the cost of all labour and material involved in the operations described above, including cost of all precautionary measures to be taken for protections and supporting all services etc met with during trenching. It does not include the cost of mixing of earth, sludge/manure.

21.1 RED EARTH

21.1.1 The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.

21.1.2 Rate: The rate shall include the cost of excavating the earth from areas lying at distance not exceeding one km. from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also includes royalty if payable.

21.2 ROUGH DRESSING OF THE TRENCHED GROUND

21.2.1 Rough dressing of the area shall include making kiaries for flooding.

21.2.2 The trenched ground shall be leveled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so leveled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at the surface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

23.2.4 Rates

The rate shall include the cost of all the labour and material involved in all the operations described above.

21.3 UPROOTING WEEDS FROM TRENCHED AREAS

21.3.1 After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

21.3.3 Rate
21.4 FINE DRESSING THE GROUND

21.4.1 Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

21.4.3 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above.

21.5 SPREADING GOOD EARTH

21.5.1 Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

21.5.3 Rate: The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of the good earth which shall be paid for separately unless specifically described in the item.

21.6 MIXING OF GOOD EARTH AND SLUDGE/MANURE

21.6.1 The stacked earth shall, before, mixing be broken down top particle of sizes not exceeding 6 mm in any direction Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-charge, sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

21.6.3 Rates
The rate shall include the cost of all labour and materials involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

21.7 GRASSING WITH SELECT GRASS

21.7.1 The area from where the grass roots are to be obtained shall be specified by the Engineer-in-Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor.

21.7.2 The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7 5 cm, 5 cm apart in any direction or other spacings as described in the item. Dead grass ancf weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material

21.7.3 During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed

21.7.4 Measurements
Length, breadth of the lawn grassed shall be measured correct to cm and the area shall be calculated in sqm. Correct to two places of decimal.

21.7.5 Rate
The rate shall include of all the labour and material involved in all the operations described above, excluding supply of the requisite quantity of good earth and grass so needed for properly maintaining the levels of the lawns.
21.8.1 In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.

21.8.1.1 Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The tree holes shall be manured with powdered Neam/castor oil cake at the specified rate of mixing along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder; (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

21.8.1.3 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, excluding the cost of supply and stacking the requisite quantity of manure/sludge and oil cake.

21.8.2 In Soil other than Ordinary Soil

21.8.2.1 Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and/or ordinary soil in any hole, the different excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only.

21.8.2.2 The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.

21.8.2.3 Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately. The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge If such places are outside initially leads, carriage for the extra lead shall be paid for separately.

21.8.2.4 The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 16 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

21.8.2.6 Rate. The rate shall include the cost of all the labour and material involved in all the operations described above, including mixing refilling, watering, dressing etc. but shall not include (a)cost of manure over sludge (b) cost of supplying and stacking of good earth for replacement and (c) the cost of carriage beyond initial lead for disposing off useless materials. The excavation other than that of ordinary soil shall be paid extra over and above the rate if excavation in ordinary soil.
### SECTION –22

**LIST OF APPROVED MAKE/VENDOR**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item</th>
<th>Approved Make /manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cement</td>
<td>Ultra Tech, ACC, Century, Grasim, Ambuja</td>
</tr>
<tr>
<td>2</td>
<td>Reinforcement Steel</td>
<td>SAIL, TISCO, RINL</td>
</tr>
<tr>
<td>3</td>
<td>Structural Steel</td>
<td>TISCO, SAIL, RINL</td>
</tr>
<tr>
<td>4</td>
<td>Grouts/Admixtures/Water proof Chemicals/</td>
<td>BASF, FOSROC, PIDILITE, SIKA, SWC,</td>
</tr>
<tr>
<td></td>
<td>Construction Chemicals</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Epoxy Flooring/PU</td>
<td>BASF, CIPY, FOSROC, SIKA, PIDILITE,</td>
</tr>
<tr>
<td>6</td>
<td>False Ceiling / Vinyl sheets /Carpets</td>
<td>Armstrong, Daiken</td>
</tr>
<tr>
<td>7</td>
<td>Galvalume Sheet And Accessories,</td>
<td>Era, Tata BlueScope, Octamec Engineering, Interarch, Japan building systems</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Supplier/Brand</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>8</td>
<td>Deck Slab/Cold Rolled Steel Sections</td>
<td>Era build system, Lloyd Insultations, Kirby, Octamec, Pennar Industries Limited</td>
</tr>
<tr>
<td>9</td>
<td>Rock Wool Insulation</td>
<td>Lloyd Insultations, Rock wool (India) Ltd, Shreeram Rock wool.</td>
</tr>
<tr>
<td>10</td>
<td>Aluminium Sections</td>
<td>NALCO, JINDAL</td>
</tr>
<tr>
<td>11</td>
<td>Glazing/Toughened Glass</td>
<td>Saint Gobin, Atul, Modi, Asai, Hindustan, IHG,</td>
</tr>
<tr>
<td>12</td>
<td>Brass / Copper Mortice Lock</td>
<td>GODREJ, Europa, ACME</td>
</tr>
<tr>
<td>13</td>
<td>Door Closer</td>
<td>Hardwin, Everite, Dorma, Godrej</td>
</tr>
<tr>
<td>14</td>
<td>Steel Door Frames</td>
<td>Guardian, Padma Eng. Works, SenHarvic, Radiant Eng, Ahalda Engrs, B.G. Shirke Const. CECO</td>
</tr>
<tr>
<td>15</td>
<td>Handles</td>
<td>Diana, Jyothi</td>
</tr>
<tr>
<td>16</td>
<td>Tower Bolts</td>
<td>Jyothi, Diana</td>
</tr>
<tr>
<td>17</td>
<td>Rolling Shutter</td>
<td>Srima Sales Corp., ABAQS, SenHarvic, Radiant Eng, Gandhi Automation, Rama Rolling shutter, Swastik Rolling shutter</td>
</tr>
<tr>
<td>18</td>
<td>Ceramic Tiles</td>
<td>Kajaria, Nitco, Johnson</td>
</tr>
<tr>
<td>19</td>
<td>Vitrified Ceramic Tiles</td>
<td>Asian, Marblito, Kajaria, Nitco</td>
</tr>
<tr>
<td>20</td>
<td>PVC Flooring</td>
<td>Krishna Vinyle, Rikvin, Armstrong, FORBO Switzerland, LG Floors.</td>
</tr>
<tr>
<td>21</td>
<td>MS Tubes</td>
<td>Jindal, TATA, Indian Tube, Zenith</td>
</tr>
<tr>
<td>22</td>
<td>PVC Pipes</td>
<td>Finolex, Sudhakar, Jain, Kisan,</td>
</tr>
<tr>
<td>23</td>
<td>Particle Board</td>
<td>Novapan, Indian plywood, Kitply, Green ply.</td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
<td>Manufacturer/Brand Names</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>24</td>
<td>Plywood/ Shuttering plywood</td>
<td>Century, Kit ply, Green ply</td>
</tr>
<tr>
<td>25</td>
<td>Paints/Distemper</td>
<td>Asian Paints, Berger, Jenson Nicholson, ICI</td>
</tr>
<tr>
<td>26</td>
<td>Laminate</td>
<td>Fevicoal, Unicoal, Vamicoal</td>
</tr>
<tr>
<td>27</td>
<td>General Steel doors/Acoustic Door/ Fire Door</td>
<td>Shakti Met Door, Ahlada Engineers Pvt. Ltd., Radiant Engineering</td>
</tr>
<tr>
<td>28</td>
<td>Flush Door</td>
<td>Indian Plywood, Kit ply, Green ply</td>
</tr>
<tr>
<td>29</td>
<td>Laminates</td>
<td>Kitlam, Greenlam, Sun gloss, Feather touch</td>
</tr>
<tr>
<td>30</td>
<td>Polysulphide Sealants</td>
<td>Fosroc, Choksi, Chemicals, Pidilite, SIKA</td>
</tr>
<tr>
<td>31</td>
<td>Welding Electrodes</td>
<td>Advani Oerlicon, Essab</td>
</tr>
<tr>
<td>32</td>
<td>White cement</td>
<td>JK , Birla</td>
</tr>
<tr>
<td>33</td>
<td>Shalitax Board</td>
<td>Shalimar Industries</td>
</tr>
<tr>
<td>34</td>
<td>Paver Blocks</td>
<td>Endura, Aeon, Besser</td>
</tr>
<tr>
<td>35</td>
<td>Poly propylene fibres</td>
<td>Reliance industries limited, Nina, JB Associates</td>
</tr>
<tr>
<td>36</td>
<td>Cast iron pipes and CI fittings</td>
<td>Kesoram, Electro steel( IS 210, IS 1536, IS 1538)</td>
</tr>
<tr>
<td>37</td>
<td>Cast iron gate valves</td>
<td>Kirloskar, Kilburn, Sarkar(IS 780)</td>
</tr>
<tr>
<td>38</td>
<td>Gun metal valves</td>
<td>Leader, Zoito, Sant (IS 778,IS 5352)</td>
</tr>
<tr>
<td>39</td>
<td>G.I. pipes</td>
<td>Tata, GST, Zenith, Jindal(IS 1239)</td>
</tr>
<tr>
<td>40</td>
<td>GI fittings</td>
<td>&quot;R&quot; or &quot;X' brand</td>
</tr>
<tr>
<td>41</td>
<td>Brass float valve</td>
<td>IS marked(IS 1703)</td>
</tr>
<tr>
<td>42</td>
<td>CP brass bib cocks, stop cocks, pillar cocks</td>
<td>ISI Marked, Jaquar, ESSCO, MARC (IS 8931 ,IS 781,IS 1711)</td>
</tr>
<tr>
<td>43</td>
<td>CP brass shower</td>
<td>ISI Marked, Jaquar, ESSCO, MARC</td>
</tr>
<tr>
<td>44</td>
<td>Hume pipes NP2</td>
<td>IS 458</td>
</tr>
<tr>
<td>45</td>
<td>Water closets</td>
<td>Parryware, Hindware, Cera</td>
</tr>
<tr>
<td>46</td>
<td>Wash basins</td>
<td>Parryware, Hindware, Cera</td>
</tr>
<tr>
<td>47</td>
<td>Urinal</td>
<td>Parryware, Hindware, Cera</td>
</tr>
<tr>
<td>48</td>
<td>Mirror</td>
<td>Modi, Saint gobain</td>
</tr>
<tr>
<td>49</td>
<td>WC seat cover</td>
<td>Commander, Parryware, Cera (IS 2548)</td>
</tr>
<tr>
<td>50</td>
<td>Auto flush system for urinal</td>
<td>AOS system, ROBO auto flush system</td>
</tr>
<tr>
<td>51</td>
<td>Ceramic flush tank</td>
<td>Parryware, Hindware, Cera</td>
</tr>
<tr>
<td>52</td>
<td>PVC flush tank</td>
<td>Parryware, Commander, Cera</td>
</tr>
<tr>
<td>53</td>
<td>Pig lead</td>
<td>Hinuxtan Zinc</td>
</tr>
<tr>
<td>54</td>
<td>Pump sets</td>
<td>Kirloskar, Crompton greaves, CRI, Texmo</td>
</tr>
<tr>
<td>55</td>
<td>non return valves, foot valves</td>
<td>Kalapakam, Leader, Zoito, Sant</td>
</tr>
<tr>
<td>56</td>
<td>UV resistant polyethylene film(silpaulin sheet)</td>
<td>Supreme industries limited,or approved equivalent</td>
</tr>
<tr>
<td>57</td>
<td>Stud Anchors, chemical adhesives for rebar fixing</td>
<td>HILTI ,FISHER, or any approved</td>
</tr>
</tbody>
</table>
Notes:

The make/brand name mentioned elsewhere in this document or BOQ shall also be applied for the respective items/materials.

The make/brand/manufacturer’s name mentioned above is indicative and provided as a guide only. All the material shall conform to the specifications in the BOQ and relevant IS Codes or other international codes if relevant IS codes are not available.

In case the relevant material with above brand names are not available or the same are not in conformity with IS, the contractor shall provide equivalent or superior brand materials as approved by Engineer in Charge. Indication of brand name as above does not relieve the contractor from using the material with superior specification as per the directions of Engineer In Charge.

The MES SSR Part-I, Specifications -2009 shall form an integral part of the contract. The specifications on materials, workmanship, quality control specified in SSR PART-1 –2009 will be applicable for all the items required to be executed for the completion of work irrespective of those specified in this Technical specification book let or not.

**List of Mandatory Tests**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Frequency</th>
<th>Tests to be carried out at</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CIVIL WORKS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Cement</td>
<td>Normal Consistency (IS 4031)</td>
<td>For Every 100MT and at Change of source</td>
<td>At Field / Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td>Fineness &amp;. Soundness(IS 4031)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Compressive strength(IS 4031)</td>
<td>---- do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Chemical composition</td>
<td>_ do —</td>
<td>At Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td>Initial &amp; Final Setting Time(IS 4031)</td>
<td>For every 50 MT and at change of source</td>
<td>At Field Laboratory</td>
</tr>
<tr>
<td>2 Coarse Aggregate</td>
<td>Sieve Analysis - particle size distribution (IS 2396)</td>
<td>For every 50 Cum and at change of source</td>
<td>At Field Laboratory</td>
</tr>
<tr>
<td></td>
<td>Percentage of Clay Lumps (IS 2386)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Specific Gravity &amp; Water absorption (IS 2386)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Flakiness index &amp; Elongation Index (IS</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Percentage of minerals finer than 75 microns (IS 2386)</td>
<td>Initial test and subsequent test as desired by the Owner &amp; Consultant</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Aggregate Crushing value (IS 2386)</td>
<td>— do —</td>
<td>Outside laboratory</td>
</tr>
<tr>
<td>3 Fine Aggregate / Sand</td>
<td>Sieve Analysis - particle size distribution (1S 2386)</td>
<td>For every 30 cm and at change of source</td>
<td>At Field laboratory</td>
</tr>
<tr>
<td></td>
<td>Percentage of Clay Lumps (IS 2430)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Percentage of material: finer than 75 microns (IS 2386)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Specific Gravity Water absorption (IS 2386)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Bulkage (IS 2386)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td>Surface moisture (IS 2386)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
</tbody>
</table>
### Water

Chemical analysis for determining suitability for use in concrete (IS 3025)

- pH Value
- Limits of acidity
- Limits of alkalinity
- Percentage of solids
  - a) chlorides
  - b) suspended matter
  - c) sulphates
  - d) inorganic solids

At starting of the Project, at every 3 months and at every change of source

<table>
<thead>
<tr>
<th>S.No</th>
<th>Item</th>
<th>Description</th>
<th>Frequency</th>
<th>Tests to be carried out at</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Admixtures</td>
<td>Chemical Composition</td>
<td>As desired by the Owner &amp; Consultant</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td>6</td>
<td>Reinforcement steel</td>
<td>Cross Sectional area</td>
<td>For Every 20MT or part thereof for each item / dia and at change of source</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bend and Re-bend Test (IS 2062)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tensile strength/Ultimate Tensile Stress (IS 1608)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td>7</td>
<td>Concrete</td>
<td>Workability (Slump Test) – IS 456</td>
<td>As desired by the Owner &amp; Consultant</td>
<td>At Field Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compressive Strength (Cube Test) – (IS 456)</td>
<td>For each concrete pour/ RCC element (No of test specimen as per IS 456)</td>
<td>At Field Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-Destructive Tests (Ultra Sonic Pulse velocity test with Schmidt Hammer Test)</td>
<td>As desired by the Owner &amp; Consultant</td>
<td>At Field by outside laboratory / agency</td>
</tr>
<tr>
<td>8</td>
<td>Structural Steel</td>
<td>Cross Sectional Area</td>
<td>For Every 20MT or part thereof and at change of source</td>
<td>Outside laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tensile Strength/ Ultimate Tensile Stress</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td>9</td>
<td>Bricks</td>
<td>Compressive strength (IS 3495)</td>
<td>For every 50000 Nos and at change of source</td>
<td>At Field/outside laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dimension (IS 1077)</td>
<td>— do —</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water Absorption &amp;</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td>10</td>
<td>Marble</td>
<td>Moisture absorption (IS 1130)</td>
<td>For marble work of Rs. 10000 or as desired by consultant</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mohs Scale hardness test</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td>11</td>
<td>Timber</td>
<td>Moisture Content (IS 11215)</td>
<td>For every 1 Cum and part thereof</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td>12</td>
<td>Flush Door</td>
<td>Emersion Test (IS 2191 and 22021)</td>
<td>As desired by the Owner &amp; Consultant</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Knife Test (IS 2191 and 22021)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adhesion (IS 2191 and 22021)</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td>13</td>
<td>Aluminum Doors, Windows &amp; Fittings</td>
<td>Thickness of anodic coating or powder coating (As applicable)</td>
<td>As desired by the Owner &amp; Consultant</td>
<td>Outside Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gauge and size of the section</td>
<td>— do —</td>
<td>At Field Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight of sections</td>
<td>— do —</td>
<td>— do —</td>
</tr>
<tr>
<td>S.No</td>
<td>Item</td>
<td>Description</td>
<td>Frequency</td>
<td>Tests to be carried out at</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
<td>Coarse aggregate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Cement concrete pavement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>under controlled conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Flakiness Index - IS 2386 (Part I)</td>
<td>Before approval of the quarry and every subsequent change in the source of supply and one test per 100 cum.</td>
<td>Out Side Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Impact Value - IS 2386 (Part IV)</td>
<td>-Do-</td>
<td>-Do-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Lose Angles abrasion Value - IS 2386 (Part IV)</td>
<td>-Do-</td>
<td>-Do-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Deleterious material IS 2386 (Part II)</td>
<td>Before approval of the quarry and at every subsequent change in the source of supply</td>
<td>-Do-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Moisture content IS 2386 (Part III)</td>
<td>Regularly as required subject to a minimum of one test per day</td>
<td>-Do-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fine Aggregate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Silt content</td>
<td>One test per 15 cum.</td>
<td>At Field Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Gradation of sand - IS 2388 (Part in)</td>
<td>-Do-</td>
<td>At Field Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Deleterious material - IS 2386 (Part II)</td>
<td>Before approval of the quarry and at every subsequent change in the source of supply</td>
<td>At Field Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Moisture content - IS 2386 (Part III)</td>
<td>Regularly as required subject to a minimum of two tests per day</td>
<td>At Field Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Mix Aggregate - IS 2366 (Part I)</td>
<td>One test per 15 cum of concrete</td>
<td>At Field Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Flexural strength - IS 526</td>
<td>One test consisting of 8 specimen for 30 cum. of concrete</td>
<td>Out Side Laboratory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WATER SUPPLY AND DRAINAGE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SW Pipes</td>
<td>Water tightness test (with 1.5m of water pressure for 30 minutes without drop of pressure) from manhole to manhole</td>
<td>For each segment before backfilling and for entire system prior to handing over</td>
<td>at field</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Straightness, gradual slope and obstructions test by using ball of dia 12mm less than the ID of the pipe</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mirror and lamp test</td>
<td>As desired by the Owner &amp; Consultant</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smoke test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Hume Pipes</td>
<td>Water tightness test (with 1.5m of water pressure for 30 minutes of pressure) from manhole to manhole</td>
<td>For each segment before backfilling and for entire system prior to handing over</td>
<td>at field</td>
</tr>
</tbody>
</table>
### List Of Field Checks

<table>
<thead>
<tr>
<th>S.No</th>
<th>Item</th>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CIVIL WORKS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Cement</td>
<td>Manufacturer’s Test Certificate</td>
<td>For each consignment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Checking Grade, Manufacturing Date, Lumps</td>
<td>do</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Checking method of storage in cement godown</td>
<td>At regular intervals (as required)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Checking records for receipt and issue</td>
<td>do</td>
</tr>
<tr>
<td>2</td>
<td>Coarse Aggregate</td>
<td>Visual Inspection for quality of materials</td>
<td>For each Truck load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Method of stacking</td>
<td>At regular intervals (as required)</td>
</tr>
<tr>
<td>3</td>
<td>Fine Aggregates</td>
<td>Visual Inspection for quality of materials</td>
<td>For each Truck load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Method of stacking</td>
<td>At regular intervals (as required)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rough Test for Silt and Clay content</td>
<td>At regular intervals (as required)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bulkage</td>
<td>do</td>
</tr>
<tr>
<td>4</td>
<td>Water</td>
<td>Checking whether it is clear water and free from any odour</td>
<td>At regular intervals (as required) and at every change of source</td>
</tr>
<tr>
<td>5</td>
<td>Admixtures</td>
<td>Manufacturer’s Test Certificate</td>
<td>For each consignment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Checking manufacturing and expiry date</td>
<td>For each pack or container</td>
</tr>
<tr>
<td>6</td>
<td>Reinforcement Steel Materials</td>
<td>Manufacturer’s Test Certificate</td>
<td>For each consignment</td>
</tr>
</tbody>
</table>

Note:

The above mentioned frequency tests are given as a Standard Engineering Practice to be followed for this project. Depending on the requirement at site and as may be found necessary by the Owner & Consultant the above tests shall be made more frequent and initial and subsequent tests shall be decided by the Owner & Consultant. In addition to the above tests other relevant tests shall also be performed as may be found necessary.

* Outside Laboratory means the Govt. Laboratories as shall be approved by the Owner & Consultant.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Reinforcement Work</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Checking whether rebars in position are as per drawing &amp; bending schedule</td>
<td>For each RCC element</td>
</tr>
<tr>
<td></td>
<td>Lap length, bored length provided</td>
<td>-----do-----</td>
</tr>
<tr>
<td></td>
<td>Cover</td>
<td>-----do-----</td>
</tr>
<tr>
<td></td>
<td>Arrangement for labour movement on reinforced area</td>
<td>-----do-----</td>
</tr>
<tr>
<td>8</td>
<td>Concrete</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Availability of required number of workmen &amp; equipment</td>
<td>For each concrete pour / RCC element</td>
</tr>
<tr>
<td></td>
<td>Availability of materials</td>
<td>-----do-----</td>
</tr>
<tr>
<td></td>
<td>Whether design mix is approved</td>
<td>do-----</td>
</tr>
<tr>
<td></td>
<td>Ensuring that Calibration of Weight Batcher is checked regularly</td>
<td>-----do-----</td>
</tr>
<tr>
<td></td>
<td>Access and pouring mechanism</td>
<td>-----do-----</td>
</tr>
<tr>
<td></td>
<td>Batching as per design mix</td>
<td>-----do-----</td>
</tr>
</tbody>
</table>
ELECTRICAL SYSTEM
1. **System / Installation covered under this tender broadly identified as follows:**

   - Electrical system (including earthing & lighting protection, telephone/data cabling) for:
     i) **Armament Aggregate Overhaul Shop**
     ii) **Mechanical & Avionics Aggregate Overhaul Shop**
     iii) **Test Station for Hydro Pneumatic Fuel Aggregates**
     iv) **Landing Gear Overhaul Shop**
     v) **Compressor House**
   - Electrical system required for new Ventilation and Chiller Plants for Test Station for Hydro Pneumatic Fuel Aggregates, Mechanical & Avionics Aggregate Overhaul Shop
   - Street Lighting for New Hangar/Shops area
   - HT Substation

2. **Scope of works covered under this tender shall be supply of necessary equipments, installation, erection, testing and commissioning of the system. The skilled & unskilled laborers, lifting tools and tackle and any other materials and equipments that may be required will be provided by the Contractor. The actual extent of work vis-à-vis the distribution system shall be as indicated in the drawings / specifications released for construction.**

3. **Following, but not limited to, shall be in the scope of the Contractor and quoted rates shall be deemed to be inclusive of the cost for the same:**

   a) Supply of all equipments / materials / accessories / consumables / hardware.
   b) Packing and forwarding of above
   c) Obtaining test certificates from approval test laboratories / authorities for the components before assembly of panels / equipments etc
   d) Arranging shop inspection for items / equipments as stipulated in the specification.
   e) Transporting to site, receiving at site, and unloading and proper storage at site.
   f) Inspection at site on receipt. periodic inspection and maintaining in proper condition during storage at site.
   g) Transporting from stores to extract location of installation.
   h) Obtaining approvals (both pre and post construction) from Statutory Authorities.
   i) Positioning, aligning, fixing, assembly and installing of items after carrying out proper cleaning and inspection.
   j) Site supervision, testing for proper functioning/operation and pre-commissioning tests.
   k) Removing dents / bends etc if found and bringing to original condition and touch up paints for scratches if any.
   l) Commissioning after all site test and obtaining approval from Central Electricity Authority.
   m) Operation of installation on load.
   n) Obtaining and maintaining comprehensive storages cum erection including living / non living, third party liabilities.
   o) Final handing over of installation
   p) Preparation of shop drawings/ cable or conduit layout drawing / working details based on drawing issued by the Consultant / Client and site conditions and obtaining approval of the same from the Consultant before commencement of work.
   q) Preparation of Final As- built drawings.
   r) Getting the drawing and complete work approved from Central Electricity Authority (CEA) for all substation equipment

4. **HAL reserves the right to procure transformers, HT & LT panels or low voltage systems separately for economic reasons. Final decision on the same will be conveyed to the successful bidder after price bid opening**

5. **It shall be the contractor’s responsibility to clear the site of the employer’s material for which contractor will provide his labor and supervision at no extra cost to Employer. However, Employer will arrange transport to shift Employer’s material to a different location within the factory area as decided by the Site-in-charge.**

6. **The Contractor has to carry out his work according to Drawings, Specifications and Bill of**
Quantities.

7. The tenderer should study the various items of the Bill of Quantities in conjunction with the Technical Data and specifications as well as General instruction as given here.

8. The rates quoted herein shall be for complete work, labors, materials and incidentals and all taxes, duties, Octori and other duties and all other cost, insurance packing and freight and shall be rates at site of work.

9. No change in drawing, design, bill of quantities and specification shall be carried out unless the same is approved by the Consultant/HAL in writing.

10. Quantities mentioned are approximate and are subject to variation as require for final execution. The Employer reserves the right to increases or decrease the quantity of work.

11. The privilege of authorship and ownership of drawings and designs remains with the Consultant. The drawings and designs prepared by the Consultant shall be used only for the purpose specified in this Contract and all drawings issued shall be returned on completion of work.

12. The Engineer, authorized by the Employer to represent at site-of-work, is authorized to ask the Contractor to discontinue any work which does not meet the expected and/or specified requirement and/or work already executed, may be rejected and asked to be removed for the same reason.

13. In the event of any discrepancy between the details on the drawings, description in the technical specifications and in the Bill of Quantities, then the item shall be deemed to have priced in accordance with the Bill of Quantities.

14. The rates quoted shall be for the complete item executed in a proper workman like manner.

15. Tenderers are required to study the various items very carefully & incase of any doubt clarification should be obtained from the Employer/Consultant before submitting the bid.

1.1 SCOPE OF THE WORK:

Scope of work covered under this tender shall be supply of the necessary equipment, installation, erection, testing and commissioning of the system. The skilled and unskilled labours as also lifting tools and tackle and any other materials and equipment that may be required will be provided by the Contractor. The actual extent of work vis-à-vis the distribution system shall be as indicated in the drawings/specifications, but not limited to following:

a) Installation(Erection) of 11 kV, 7 Module Indoor, VCB HT panels to receive power with CT & PT & metering.

b) Installation(Erection) of 2 Nos. 1600 kVA, 11 kV / 380 V oil cooled type indoor transformers with OLTC, RTCC and AVR, 2 Nos of 2000 kVA, 11 kV / 433 V oil cooled type indoor transformers with OLTC, RTCC, AVR and 1 No of 2500 kVA, 11 kV / 433 V oil cooled type indoor transformer with OLTC, RTCC and AVR.

c) Supply, installation, testing and commissioning of Power distribution boards, Power & Control cables, Terminations of cables, Cable trays etc.

d) Supply, installation testing and commissioning of Socket DB’s, Power socket outlets, Isolators, Small socket board’s(SSB’s) etc.

e) Supply, installation, testing and commissioning of Automatic Power Factor Improvement Panel and Capacitors.

f) Supply, installation, testing and commissioning of LDB’s, Lighting fixtures, Emergency lighting, Street lighting etc

g) Supply, installation, testing and commissioning of Earthing system and Lightning protection system

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 206 of 494
h) Supply, installation, testing and commissioning of HT and LT power cables and control cables.

i) Supply, installation, testing and commissioning of wiring for Telephone system and LAN system, LAN equipments, PA system etc.

j) Getting the drawing and complete work approved from Central Electricity Authority (CEA) for all substation equipment.

12 GENERAL CONDITION

a) The Specification and the Drawings are complementary and any item which is described in the Specification and not shown on the Drawings, or vise versa, and is necessary or incidental to the electrical work must be furnished and installed within the Contract.

b) HAL reserves the right to procure transformers, HT & LT panels or low voltage systems separately for economic reasons. Final decision on the same will be conveyed to the successful bidder after price bid opening.

13 QUALITY OF MATERIALS & GENERAL STANDARDS OF WORK

The contractor should commit himself to use materials listed under "APPROVED MAKE" only. Materials, equipments, fittings, etc. used in the installation shall conform to the latest relevant IS. In case of materials for which standard specifications do not exist, the Consultant / Client's Engineer-in-charge before start of work shall be approved the material.

Also the contractor should full responsibility for the quality of all material incorporated brought for incorporation in the work. The work shall be executed in accordance with Engineering Practice and as per directions of Consultants.

14 CODE, REGULATIONS AND STANDARDS:

Classification of degrees of protection provided by enclosures of electrical equipment 12063:1987 06

Electro-technical vocabulary: Part 8 Secondary cells and batteries (first revision) (Superseding IS:1174) 1885 (Part 8) :1986 04

Electro-technical vocabulary: Part 9 Electrical relays (Second revision 1885 (Part 9) :1992 07 of IS:1885)

Electro-technical vocabulary: Part 10 Power system protection (first revision of IS 1885) 1885 (Part 10) :1993 03

Electro-technical vocabulary: Part 11 Electrical measurements 1885 (Part 11) : 1966 09

Electro-technical vocabulary: Part 16 Lighting, Section 2 General illumination, lighting fittings and lighting and traffic and signaling. 1885 (Part 16- Section 3):1967 10

Electro-technical vocabulary: Part 17 Switchgear and control gear (first revision) 1885 (Part 17) :1979 08


Electro-technical Vocabulary: Part 32 Electric cables (first revision of IS 1885) 1885 (Part 32): 1992 05


Electro-technical vocabulary: Part 54 Insulators (First revision of IS 1885) 1885 (Part 54):1993 03
Electro-technical vocabulary: Part 55 Electric fans
1885 (Part 55):1981 03

Electro-technical vocabulary: Part 69 Generation, transmission and distribution of electricity – Generation
1885 (Part 69):1993 04

Electro-technical vocabulary: Part 71 Generation, transmission and distribution of electricity Substation
1885 (Part 71):1993 06

Graphical symbols for diagrams in the field of electro-technology: Part 3 Conductors and connecting devices
12032 (Part 3):1987 05

Graphical symbols for diagrams in the field of electro-technology: Part 12032(Part 7):1987 12
7 Switchgear, control gear and protective devices.

Graphical symbols for diagrams in the field of electro-technology: Part 12032(Part 8):1987 07
8 Measuring instruments, lamps and signaling devices.

Guide for color coding of electrical mimic diagrams
11954:1987 02

8207(Part I):1976 02

AC supplied electronic ballasts for tubular florescent lamps: Part I, General and safety requirements.
13021(Part 2):1991 05

Ballasts for high pressure mercury vapor lamps (first revision)
6616:1982 08

Bayonet lamp holders (third revision)(with amendment no.2)
1258:2005

High pressure mercury vapor lamps
9900(Part 1 to 4):1981

Code of practice for Earthing
3043:1987

Code of practice for electrical wiring installations (third revision)
732:1989

Code of practice for the installation of electric bells and call system
8916:58:03

Code of practice for the protection of buildings and allied structures 2309 : 1989 against lighting (second revision)

Danger notice plates (first revision)
2551:1982


Low and medium supply voltages


Special publication - National Electrical Code
30:1984

Special publication Chart on treatment for electric shock
31:1986

Warning symbol for dangerous voltages
8923:1978 01

Accessories for rigid steel conduits for electrical wiring (first revision) 3837:1976 04

Adaptors for flexible steel conduits 4649:1968 03

Appliance-connectors and appliance-inlets (non-reversible three-pin 3010(Part 1):1965 05 type): Part 1, Appliance connectors (with amendment No.6)

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Boxes for enclosure of the electrical accessories: Part 1, Steel and cast iron box (with amendment No.2)

Boxes for the enclosure of electrical accessories: Part 2, Boxes made of insulating material

Ceiling roses (second revision) (with amendment No.4)

Conduits for electrical installations: Part I, General requirements


Conduits for electrical installation: Part 2, Rigid steel conduits (sup

Fittings for rigid non-metallic conduits (second revision)

Fittings for rigid steel conduits for electrical wiring (first revision)

Interlocking switch socket outlet

Plugs and socket outlets of rated voltage up to and including 250 volts and rated current up to and including 16 Amps (third revision)

AC electricity meters: Part 3, Three-phase whole current and transformer operated and single-phase transformer operated watt-hour meters, class 2(Second revision)(with amendment No.2)

AC electricity meters: Part 5, Volt-ampere hour meters for restricted power factor range, class 3.5 (first revision) (with amendment No.2)

Guide for testing, calibration and maintenance of AC electricity meters: Part 1, Single phase whole current watt hour meters, Class 2.0 (first revision)

Maximum Demand indicators (class 1)

Testing equipment for AC electrical energy meters

Application guide for the selection of High Voltage fuses for transformer circuit applications.

Carriers and bases used in rewirable type electric fuses for voltages 2086:1993 up to 650 V (third revision)

High voltage fuses: Part 2, Current limiting fuses.


LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part I, General requirements

LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part 2, fuses for use by authorized persons, Section 1, Supplementary requirements

Specifications for LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC

Application guide for measuring devices for high voltage testing Methods of high voltage testing: Part 1, General definitions and test requirements, (first revision) (Superseding IS: 2070-1972)

AC contactors of voltage above 1000 V up to and including 11000 V

Alternating current dis-connector (isolators) and Earthing switches for voltages above 1000 V: Part General and definitions
for voltage above 1000 V: Part 1 - General and definitions.
Alternating current dis-connectors (isolators) and Earthing switches for voltage above 1000 V: Part 2 - Rating.
Alternating current dis-connectors (isolators) and Earthing switches for voltages above 1000 V: Part 3 - Design and construction
Alternating current dis-connectors (isolators) and Earthing switches for voltages above 1000 V: Part 4 - Type tests and routine tests.
Alternating current dis-connectors (isolators) and Earthing switches for voltages above 1000 V: Part 5 - Information to be given with tender enquiries and orders
Dimensions of terminals of high voltage switchgear and control gear. 10634:03:00
General requirements for circuit breakers for voltages above 1000 V. 13118:1991
General requirements for switchgear and control gear for voltages exceeding 1000 V 12729:1988
Guide for testing of circuit breakers with respect to out-of-phase switching. 9135:1979
Interconnecting bus bars for AC voltage above 1 kV up to and including 36 kV 8116:56:00
Metal-enclosed switchgear and control gear for voltage above 1000 V 3459:49:00 but not exceeding 11000 volts (with amendment No.1)
Methods of synthetic testing of high voltage alternating current circuit 13549:13:00
breakers.
Switches and switch isolators for voltages above 1 000V: Part 3 Design and Construction 9920(Part 3):1982
Application guide for voltage transformers (first revision) 4146:1993
Current transformers: Part 1, General requirements (second revision) 2705(Part 1):1 992
Current transformer: Part 4, Protective current transformers for special purpose applications (Second revision) 2705(Part 4): 1992
Voltage transformers: Part 1, General requirements (second revision) 3156(Part 1):1992
Voltage transformers: Part 2, Measuring voltage transformers (second revision) 3156(Part 2):1992
Voltage transformers: Part 3, Protective voltage transformers (second 3156 (Part 3):1992 revision)
Voltage transformers: Part 4, Capacitor voltage transformer (second 3156(Part 4):1992 revision)
Circuit Breakers for over current protection for household and similar 8861:13:00 installations (first revision)
Part 1 - General

Part 2 - Selection

Part 3 - Installation.

Part 4 – Maintenance

Identification of terminals of contactors and associated overload relays 10738:03:00

LV switchgear and control gear, Part 2 - Circuit breakers 13947(Part 2): 1993
LV switchgear and control gear Part 3, Switches, dis-connectors, switch dis-connectors and fuse combination unit 13947(Part 3):1993

LV switchgear and control gear Part 4, Contactors and motor starters 1394 7(Part 4)-section 1):1993
LV switchgear and control gear Part 5, Control circuit devices and switching elements, Section 1 Electromechanical control device (All 1):1993 (parts)) 1394 7(Part 5)-Section

Miniature circuit breaker boards for voltage up to and including 1000 13065:11:00 volts AC.

Specification for low voltage switchgear and control gear assemblies: 8623(Part 1):1993 Part 1, Requirements for type-tested and partially type tested assemblies (first revision)

Specification for low voltage switchgear and control gear assemblies: 8623(Part 2):1993 Part 2, Particular requirements for bus bar trunking systems (bus ways) (first revision)

LV Switchgear and control gear assemblies: Part 3, Particular requirements for equipment where unskilled persons have access for their use. 8623(Part 3):1993

Brass glands for PVC cables 12943:1990

Cast iron joints boxes for tee and branch trouser joints suitable for paper insulated cables for voltages up to and including 11 kV. 10639:03:00

Code of practice for installation and maintenance of power cables up 1288:03:00 to and including 33 kV rating (second revision)

Compression type tubular in-line connectors for aluminum conductors 8341:13:00 of insulated cables (first revision)

Compression type tubular terminal ends for aluminum conductors of 8342:13:00 insulated (with amendment No.1) Conductors for insulated electric cables and flexible cords (first revision) 8163:04:00

Cross linked polyethylene insulated PVC sheathed cables: Part 1 for 7098(Part 1):1988 8orkin olta e to and incl din 1100 V Second re ision'

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 211 of 494
working voltage up to and including 1100 V (Second revision)

Cross linked polyethylene insulated PVC sheathed cables: Part 2 for 7098(Part 2):1985
working voltage from 3.3 kV up to and including 33 kV (first revision)

Drums for electric cables. 10418:1982

Methods of test for cables : Part 0, General 10810(Part 0):1984

PVC insulated cables for working voltages up to and including 1100 V 694:1990
(Third revision)

Application guide for electrical relays for AC systems: Part 1, Over
current relays for feeders and transformers

Application guide for electrical relays for AC systems: Part 2, Over
current relays for generators and motors

Application guide for electrical relays for AC systems: Part 3, Phase
unbalance relays including negative phase sequence relays (with
amendment No.1)

Application guide for electrical relays for AC systems: Part 4, Thermal
relays (with amendment No.1)

Application guide for electrical relays for AC systems: Part 5,
Distance protection relays

Application guide for electrical relays for AC systems: Part 6, Power
relays.

Application guide for electrical relays for AC systems: Part 7)
Frequency relays.

Application guide for electrical relays for AC systems: Part 8, Voltage
relays.

Application guide for electrical relays for AC systems: Part 9, Relays
for bus bar protection.

Application guide for electrical relays for AC systems: Part 10, Relays
for transverse differential protection

Application guide for electrical relays for AC systems: Part 12,
Differential relays for transformers.

Specification for electrical relays for power system protection (with
amendment No.4)

Application guide for on-load tap changers 8478:1977

Application guide for power transformers 10561:1983

Cable sealing boxes for oil immersed transformers suitable for paper 9147:1979
insulated lead sheathed cables for highest system voltages from 12
kV up to and including 36 kV.

Code of practice for selection, installation and maintenance of
transformers: Part 1- Selection.

Code of practice for selection, installation and maintenance of
transformers: Part 2- Installation (Superseding IS:1886)

Outdoor type three-phase distribution transformers up to and
including 1 00kVA, 11kV, Part 1 - Non-sealed type

Outdoor type three-phase distribution transformers up to and
including 1100 kVA 11 kV Part II Sealed t
including 100kVA, 11kV: Part II - Sealed type

Power transformers: Part 1, General (First revision) 2026(Part I):1 977
Flame proof enclosures of electrical apparatus (First revision) 2148:1968
Guide for selection of electrical equipment of hazardous area (First revision) 5603:59:00
Classification of hazardous areas for electrical installations: Part I, Areas having gases & vapors (first revision) 5572(Part I):1978
New Insulating oil for transformers and switch gear (Third revision) 335 -1993
Specification for PVC insulated (heavy duty) electric cables Part I For working voltages up to and including 1100 volts (Third revision) 1554-(Part I) 1988
Specification for PVC insulated (heavy duty) electric cables Part 2 For working voltages up to and including 1100 volts (Third revision) 1554-(Part 2) 1988
Code of practice for fire safety of buildings (general) Electrical Installations 1646-1997

Industrial luminaries with metal reflectors (First revision) 1777-1978
General and Safety requirements for luminaries Part I, Tubular fluorescent lamps (Second Edition) 1913-(Part I) -1978
Starters for fluorescent lamps 2215-1983
Code of practice for protection of buildings and allied structures against lighting (Second Revision) 2309-1989
Specifications for Tubular fluorescent lamps for general lighting services 2418_(Part 1 to 4) – 1977
Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000 volts (Second revision) 2675-1983
Code of Practice for fire safety of industrial buildings- Electrical generating and distribution stations (Second Revision) 3034:1993
Specifications for Surge Arresters for Alternating Current systems Part I –Non – linear resistor type Surge Arresters (Second revision) 3070-(Part I) -1985
Lighting Arresters for Alternating Current systems. Part 2 Expulsion 3070-(Part 2) -1989
Lighting Arresters for Alternating Current systems. Part 3 metal oxide 3070-(Part 3) -1993

arresters without gap.
Industrial light fittings with plastic reflectors 3287:1965
Holders for starters for tubular fluorescent lamps (First Revision) 3324-1982
AC metal enclosed switchgear and control gear for rated voltages above 1 KV and upto and including 52 KV (First revision) 3427-1997
Specifications for distribution pillars for voltages not exceeding 1000 Volts DC (First Revision) 5093-1983
Code of practice for design installation and maintenance of service lines upto and including 650 V 8061-1976
Specifications for PVC insulated (heavy duty) electric cables Part I for 1554(Part –1) 1988 working voltages upto and including 1100 volts (Third revision)
1.5 SCAFFOLDING

All scaffolding and ladders required for the proper execution of the work shall be provided by the contractor.

1.6 MEASUREMENTS:

The contractor shall provide all the measuring tapes and other accessories necessary instruments for measurement purpose.

1.7 POWER FOR CONSTRUCTION:

As per HAL’s General Terms and Conditions, electricity will be provided for operation of hand tools, welding machines and other appliances as required. Charges towards electricity will be billed as per existing rates applicable uniformly for all other contracts. The contractor should bring and install a three phase energy meter for billing purpose. The three phase energy meter should be certified by the testing department of MSEDCL and duly sealed.

1.8 TOOLS AND MACHINERY EQUIPMENTS:

a) The tenderer along with his tender should furnish a list of tools, plant and machinery ‘intends to use on the works. The contractor is obliged to use all machinery mentioned in his list of the contract considering it as necessary.

b) Procedure to be followed for bringing and returning of Tools:

i) All tools and returnable items should be brought by the contractor within the premises of HAL on the contractor’s delivery challan. It will be the contractor’s responsibility to take coordination from HAL security on the challan while bringing the items inside the premises of HAL. The contractor is also required to preserve all the challans in separate file.

ii) The contractor may take the tools and returnable material out of the HAL premises for repair, replacement or on permanent basis during the execution of work or after completion of the work. Necessary Non-Returnable Gate Pass will be issued by the concerned Engineer -In-Charge of HAL on the basis of the delivery challan against which the material was brought inside the factory.

1.9 DRAWINGS

The drawings, specifications and bill of quantities shall be considered, as a part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice versa, shall be executed as if specifically called for in both. The contract drawings indicated the extent and general arrangement of various equipment and their wiring etc. and are essentially diagrammatic. The drawings broadly suggest the routes to be followed.

The work shall be installed as indicated on the drawings. However, any minor change if found essential to coordinate the installation of this work with other departments shall be made without any additional cost to the client. The drawings and specifications are for the assistance and guidance to the contractor only and the exact location, distances and levels, etc. will be
The contractor shall make following drawings and obtain approval from Consultant/Client before starting of work:

a) Layout of Substation, foundation details, bus duct routing and cable schedule & cable tray routing with fixing details.
b) General arrangement drawing with bill of material, foundation details & control wiring drawing of all equipment under his scope of supply.
c) Cable & conduit routing with mounting /circuit details and other shop drawing.
d) Earthing scheme/size layout, location of earth stations with calculations.
e) Complete layout drawings.
f) Complete schematic diagram of the installation.
g) Any other details as required.
h) Revision of drawings as and when required and obtains approval from consultant.
i) Preparing necessary drawings and obtaining approval of installation by Central Electricity Authority and various Statutory Authorities.

1.10 AS BUILT DRAWINGS/OPERATION AND MAINTENANCE MANUALS / INSPECTION AND TEST REPORT:

The contractor shall submit one complete set of original drawings and three copies of blue prints of the latest revised execution drawings with updated details as per site conditions. Operation and maintenance manual with ITP properly documented shall be submitted in two sets for all equipments supplied and erected by the contractor.

1.11 TESTING/INSPECTION OF MATERIALS

Procedure to be followed to Ensure Quality of Materials:

a) The contractor will be fully responsible for the quality of all material incorporated or brought for incorporation in the work. The contractor should follow the following procedure.

b) For major materials like transformers, switchgear panels, VCB panels, Main LT Panels etc which are made to order the contractor should offer the items for Pre Dispatch Inspection before supply. Ensuring Type Test approval by CPRI or such authorized agency wherever mentioned in the specifications is the responsibility of the contractor and no additional charge shall be paid by the Client.

c) The contractor should give a written intimation for PDI along with following relevant details: a) Item to be inspected b) Place of Inspection c) Proposed date of Inspection after confirmation of readiness of the item.

d) Subsequent to receipt of intimation of PDI, either the PDI will be carried out or based on the testing reports and standard document submitted or the same may be waived off. In case the PDI is carried, the inspection team will consists of representatives of either Client or Consultant or both.

e) The decision of waive off of PDI rests with Client and the Consultant and the same will be intimated in writing to the contractor.

f) The cost incurred on PDI in respect of the HAL team deputed for PDI shall be borne by HAL.
g) For standard electrical items like light fittings, fans, switches, sockets, wires, and other electrical items, etc the contractor should supply sample for approval. The material should be supplied along with delivery challan, document mentioning batch number, and other related documents like test certificates for the batch or any other document from the OEM to establish genuineness of supply of these materials and their conformance to tender specifications to the satisfaction of the Consultant/HAL.

h) Irrespective of the supply of test documents of the supplied material, HAL reserves the right to carry out additional tests on sample basis or contact the OEM to establish/confirm genuineness of the items. The test will be carried out from Govt. Approved Testing Houses. The findings of the test will be final and binding on the contractor. The cost toward this activity shall be borne by HAL.

1.12 TESTING AND COMMISSIONING

a) All checks and tests as per the Manufacturer’s drawings / manuals, relevant code of installation and commissioning for various types of equipments shall be carried out by the contractor as a part of installation work.

b) High voltage testing by voltage boosters, relay calibration by secondary injection and meter calibration have to be carried out at site by authorized agencies before commissioning.

c) The client may ask for additional tests on site that are necessary to determine the works compliance with the Specifications, Manufacturer’s guarantee / instructions or the applicable code of installation. The contractor shall carry out such additional tests also without any additional cost.

d) The Client’s authorized representative should be present during every test as called by the Client. The Contractor should record all test values and furnish the required copies of the test data to the client. Electrical circuits and equipments shall be energized or used at nominal operating voltage only after the Client has accepted such reports as satisfactory.

1.13 GUARANTEE

Equipment and the installation shall be guaranteed for a period of one year against defective materials and workmanship from the date the plant and installation has been finally taken over. The contractor shall rectify the defects and replace defective materials at his own cost during the guarantee period.

1.14 WORKMANSHIP

Good workmanship and neat appearance are the prerequisites for compliance with the various sections of these specifications. Work shall be carried out in accordance with the statutory rules and local regulations in force and conform to relevant I.E Rules and IS Specifications.
1.15 TOOLS AND SPARE PARTS

The contractor shall obtain himself all special tools and tackle required for erection and assembly of the equipment covered by the contract himself.

1.16 PREPARATION OF DETAILED DRAWINGS OF THE SUBSTATION AND COMPLETE ELECTRIFICATION OF PACKAGE II AND TEST COMMISSIONING, FINAL COMMISSIONING AFTER OBTAINING APPROVAL FROM CENTRAL ELECTRICITY AUTHORITY:

Preparation of detailed drawing of the substation and complete electrification scheme fully complained with the relevant standards of drawings as per Indian Electricity Act. This includes:

1. Preparation of proposed drawings as per electrical standards.

2. Test Commissioning of the system

3. Final Commissioning: This work is inclusive of
   a) Liaisoning with Central Electricity Authority (CEA) for obtain their permission/approval for energisation of electrical installation for final commissioning
   b) Filing all relevant applications as per Procedure of CEA
   c) Furnishing technical information as required by CEA
   d) Payment of all applicable fees as required for obtaining approval and all incidental costs (if any) must be borne by the Contractor and he shall not seek Clients assistance for obtaining the relevant documents.

1.17 DOCUMENTATION TO BE MAINTAINED FOR ITEMS SUPPLIED AGAINST THE CONTRACT

a) The Delivery Challan of the supplied material with endorsement from HAL security, test certificate, warranty certificate and other related documents to items should be persevered by the contractor in a separate file. The same should be made available for reference as and when required by the monitoring Engineer –In-Charge during the execution of the work. The contractor should finally submit this file after the completion of the work to the Client

b) The contractor has to supply various electrical materials in suitable lots commensurate with the planned phase wise execution of the work so as to ensure that bulk of the material supplied is installed.

1.18 EXTRA ITEM

If any need arises for any additional item during the execution of work as per the site condition and not covered in the Bill of Quantities, the rate shall either be derived from the tenders items
or substantiated by a rate analysis.

1.19 GENERAL SCOPE

a) The contractor should co-operate with other contractors at site in all matters of common interest through the Consultant / Client / Engineer-in-charge, so that there should not be any obstruction to others and to ensure the safety of all personnel and works covered under this specification.

b) Any mis-handling or loosing of equipments/component parts, after taken over by the Contractor from the Manufacturer till the complete installation / inspection shall be contractor responsibility only.

c) The Contractor should maintain cleanliness around the work area after completion of work to the satisfaction of the Consultant/ Client. In case the cleaning is not up to the mark of Client's satisfaction, Client will have every right to carryout the cleaning operations and any expenditure incurred by the Client in this regard will be to the Contractor's account

d) In order to avoid hazards to personnel moving around the equipment like switchgears etc., which are kept charged after installation and before commissioning, contractor shall be suitably cordoned off to prevent anyone accidentally going near it.

e) The Contractor shall carry out touch up painting on any equipment indicated by the Consultant/Client, if the finish paint on the equipment is soiled or marred during installation or handling.

f) Equipment shall be installed in a professional manner so that it is novel, plumb, and square and properly aligned and oriented. No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by the Consultant/ Client

1.20 SAMPLES

The Contractor should submit two sets of samples of accessories or apparatus that are proposed to use in the installation to the Consultant/Client for approval.

The contractor as required shall submit drawings of samples and this specification shall not be departed from without the written instructions from the Consultant/Client. The verbal approval given by the Consultant to any drawings or samples submitted by the Contractor shall in no way exonerate the Contractor from their liability to carry out the work in accordance with the forms of contract. The Contractor should start the work only after obtaining approval from the Consultant/Client and that too in writing only.

1.21 CHANGES IN QUANTITY

Client reserves the right to amend or reduce the quantities to be supplied and erected as necessary and for any such amendments the unit rates offered by Contractor shall apply
1.22 HANDING OVER AND TAKING OVER OF WORKS/EQUIPMENT/SYSTEMS

The Contractor should hand over the works / equipments / systems covered under this contract only after they have been completely installed, tested and commissioned in all respects by the Contractor to the entire satisfaction of the Consultant/Client.

All relevant test forms/certificates operation and maintenance manual's, as built drawings, etc. should be forwarded to the Client. Any incomplete / partly commissioned works / equipments / system will not be taken over by the Client. In this regard, the decision of the Client / Consultant will be final and binding on the Contractor.

1.23 SPECIFICATION FOR INSTALLATION(ERECTION) OF 11 kV, 7 MODULE, INDOOR, VCB PANEL

1.23.1 Installation of Switchgear shall be in accordance with IS (latest edition) and manufacturers instruction.

IS 1011 8(Part I) –1982 : Code of Practice for selection, installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66)
; Part 1 - General

IS 10118(Part II) –1982 : Code of Practice for selection , installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66)
; Part 2 - Selection

IS 10118(Part III)–1982 : Code of Practice for selection , installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66)
; Part 3 – Installation

IS 10118(Part II) –1982 : Code of Practice for selection , installation and maintenance of switch gears and control gears (superseding IS 3072-75 & 3106-66)
; Part 4 - Maintenance

IS 2551 : Danger Notice Plates(First Revision)

IS 3043: 1987 Code of practice of earthing(First revision)

1.23.2 Handling

Switchgears and all its accessories shall be handled carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear, while using jacking pads utmost care shall be taken in proper application of jacks.

Where switchgear is dragged or pulled on sleepers or rollers, traction eyes provided at the
1.23.3 General Requirements

a) Environment within the switch room shall be kept to acceptable limits to allow equipment storage and installation to take place without damage.

b) Under no circumstances shall any item of equipment be forced. Every fit will have been checked in the Manufacturer's works and if force is required the equipment shall be rechecked, realigned and the necessary corrective action taken until force is not required.

c) Only the correct size and type of tools shall be used in the erection of switchgear.

d) Should finish paint chip off or crinkle during transit/handling installation, the contractor shall arrange for repainting the equipment at site at his own cost.

1.23.4 Foundations And Positions

a) Base plates for switchgear shall be installed before final screening of the switch room floor. Panels shall be installed over a trench.

b) Switch room floor screening shall be completed and leveled before switchgear is brought into the substation and installed.

c) Floor fixings shall be checked to ensure that they are level, in the correct position to match the fixings of the switchgear, and in accordance with dimensions given on the drawings. Correct clearances and also location of cables inlet / outlet shall be checked in relation to trenches holes through slabs, ducts, etc.

1.23.5 Installation

a) Before installation starts switch room floor shall be clean and tidy.

b) Installation of switchgear shall be executed in accordance with the Vendor’s information.

c) Only nuts, bolts and washers supplied with switchgear shall be used for bolting switchgear, bus bars, etc.
d) The center section shall be installed first (in its final position), such that when the complete switchboard is finally erected, correct clearances are obtained.

e) The center section shall be checked to ensure that it is vertical.

f) The center section shall be kept as flush to the floor as possible. It shall, if possible, be in direct contact with the fixing channel, so allowing any out-of-level flooring to be evenly spread over the whole length of the switchboard. Initially, fixing bolts shall be hand-tight only.

g) Before placing each section, checks shall be made for any items such as bushings, taps, wires, links, packing, etc., that need to be threaded or inserted, before placing of the adjacent section, ensuring that such items are not tightened.

h) Final placing of sections to either side of the center section shall be undertaken alternately, with leveling and shimming as necessary

i) Serial numbers of each unit shall be checked against arrangement drawings to ensure that each section occupies its correct position.

j) Bolts shall be placed through each side panel and hand-tightened accurately, ensuring lining-up the switchboard until the whole switchboard is installed.

k) Each section shall be bolted, and tight, to the fixing channel.

l) Fixing bolts shall be used in every position that has been provided for them.

m) Bus bar contact surfaces and tee-off connector surfaces shall be checked to ensure that they are clean on both sides.

n) After cleaning, faces shall be wiped with a clean rag to remove all dust; particular care shall be taken to keep metal dust from bus-bar insulation

o) Starting at the center section and working outwards in each direction, floor fixing bolts shall be tightened on each unit in turn, taking up even pressure on each bolt.

p) As each panel is complete, checks shall be made to confirm that it is perfectly vertical. All units shall be complete in this manner. Between fixing of sections, Bus bar and insulators shall be checked to ensure that no strain is placed on them

q) Following tightening of each section, alignment shall be checked to ensure that all withdraw able units can be inserted and withdrawn. All doors shall be checked for
proper operation

r) Working from the center, each pair of side panels shall be tightened together. All buses and earth connection shall be tightened. Working from the center section, bus bars shall be tightened and insulators checked.

s) Positioning and tightening of bus bars shall be such that no strain is placed on insulators, tee-off connectors, etc. and bus bars are correctly aligned.

u) All extraneous material, objects, etc. shall be removed from the bus-bar chamber and bus-bar covers replaced.

1.23.6 Connections

It shall be ensured by the contractor that the connections between units are properly made and are tight. When two or more switch gears are to be connected together to form a switch board, they shall be aligned and bus bars shall be connected in such a way as to provide adequate clearance between phases, and phase and neutral. When making connections to terminals of switchgear, care shall be taken to avoid undue strain on insulators.

1.23.7 Earthing And Bonding

Switchboard shall be earthed and bonded in accordance with the Earthing layout design drawings, the Manufacturer’s instructions and as per IS 3043-1987

1.23.8 Instruments And Relays

a) Any instruments or relays supplied loose with switchboards shall be fitted, and connected in accordance with the vendor’s diagrams.

b) All relays shall be cleaned of dust, and shall have all packing and shipping stops removed. Compressed Air shall not be used to clean internal relay parts.

c) Before any loose items are fitted they shall be checked against the drawings to ensure that they are fitted in the correct position on the correct section.

1.23.9 Wiring

When loose items of equipment have been fixed, they shall be connected in accordance with the wiring diagrams.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
1.23.10 Termination

Termination of 11 kV, High Tension, XLPE insulated cable in to the VCB panels (Module) with all cable termination accessories such as cable sockets, compression joint sleeves, conducting jelly’s, cable glands, reducing bushes, check nuts etc will be in the contractor’s scope.

1.23.11 Labelling

1) Destination : Each switchgear, each panel, each cubicle, each components mounted on doors, panels, and removable covers, are double labeled, internally (with the functional diagram code), and externally (with the functional text for the operator)

2) Material : black synthetic strip, engraved.

3) Fixing : snapped or screwed or riveted, gluing or similar is not allowed

4) Additional safety : danger board and other mandatory and usual warnings on front and on back of each Switchgear.

1.24 SPECIFICATION FOR SUPPLY OF HT CABLES

1.24.1 Standards

The following Standards and Rules shall be applicable amended up to date


IS : 8130-1976 Conductors for Insulated Electric Cables and Flexible Cords.

IS : 3975-1979 Mild Steel wires, strips and tapes for armouring of Cables

IS : 3961-1967 Recommended current rating for cables.

IS : 1255-1985 Code of Practice for installation and maintenance of paper insulated power cables (up to and including 33 KV).


IEC 502/94 - XLPE insulated sheathed cables for electricity supply

1.24.2 Rating
The conductors shall be made from E1 critical grade high conductivity aluminum wires of Stranded type to form sector shaped conductor. The conductors shall conform to IS 8130 1976 (amended up to date). and IS 7098 (Part-2)/1985.

Aluminium conductor used in HT Cable shall be stranded, compacted and round to achieve minimum electrical stress.

The Aluminium conductor shall have a semi-conductor layer of XLPE suitable thickness wrapped in such way that it covers the conductor entirely.

The main insulation shall be of cross linked polyethylene (XLPE) in natural colour and shall be free of air voids and foreign material.

The insulation shall be covered with another layer of semi conducting layer followed by copper tape to provide suitable earthing around the each core to keep the electrical stress radial.

Each Core shall have a numbered/colored polyester tape applied over the copper tape for identification of all three core.

Inter sheath over the laid up cores shall be of thermoplastic extruded type and armoring over the inner sheath shall be galvanised steel wire or stripes of adequate size to give mechanical protection and PVC FRLS (Flame Retardant law Smoke) outer sheath over the armour shall also be adequate thickness all as specified in the IS.

The XLPE Cable shall be suitable to withstand minimum conductor temperature of 90 deg C and 250 deg C operation and short circuit respectively and these cable shall be manufactured by triple extrusion using single (common) cross head extrusion technique and dry cure inert gas cured cross linking progress.

1.24.3 Current Ratings

The continuous current ratings of the cables shall be based on the following conditions:

a) Maximum conductor temperature –90 deg C
b) Ambient Air temperature – 40 deg C
c) Ground Temperature –30 deg C
d) Thermal resistivity of soil – 150 C Cm/W
e) Depth of laying - 1500 mm

1.24.4 Short Circuit Rating
The short circuit rating for one second shall be as per IS 692 1973 (up to date) and based on the following:

a) Maximum conductor temperature - 90 deg C
   under full load condition.

b) Maximum permissible temperature - 250 deg C
   of conductor during short circuit.

1.24.5 Testing And Inspection

a) Tests shall be carried out at manufacturer’s works.

b) The cables shall be subjected to ‘Routine Tests’ i.e conductor resistance at 20 deg C and A.C voltage test as per relevant IS.

c) Type test certificates and results as per IS 692 shall be furnished.

d) 6 copies each of the above test certificates shall be submitted to the Owners

1.24.6 Packing, Marking And Transport

1) The cables shall be supplied on strong wooden drums of suitable size barrel diameter. The inner end of the cable shall protrude out from the drums flange and is fully protected against any mechanical damage and effectively sealed against increase of moisture with heat shrink end caps. The drum is overall lagged with wooden battens and steel straps.

   Each cable drum is marked with particulars of cable size, voltage class, length, direction of rolling, position of outer end, gross weight ISI certification mark.

2)

1.24.7 Specification For Installation of HT Cables

1.24.7.1 High Tension Cable

HT cable shall be laid in trenches unless otherwise specified. Generally, laying, jointing and commissioning shall be as per regulations of local authorities. The cable should be laid as per IS 1255 : 1983.

1.24.7.2 Storing
On receipt of HT cable at site, cable shall be inspected to detect any damage. The ends of cable shall be in sealed condition. After inspection, cable shall be located in a proper place with battens of cable drums being replaced.

The cable drums shall not be stored 'on flat' with flanges horizontal. Consultant/Client will inspect the cable before storing. Contractor shall take out samples from the drums as per their instructions and send them to the manufacturer to conduct the approval tests. After the receipt of the test analysis, the cable will be accepted by the Consultant/Client.

1.24.7.3 Cables And Cable Entries

Particular attention is drawn to the Contractor’s responsibilities in safeguarding cable stored / laid in outdoor locations and unfinished buildings. Such equipment is particularly vulnerable to damage from water and dust penetration.

The Contractor shall ensure that the cable is protected in this respect while installation work is proceeding. Covers temporarily removed from trenches/entries for purpose of installation shall be reassembled on completion of the work and replaced when such work is suspended or otherwise left incomplete.

Similarly, all entries shall at times be effectively sealed against ingress of water and dust, e.g., Duct entries shall be sealed by the insertion of proprietary stopper plugs or approved means.

1.24.7.4 Handling Of Cable

Storage & handling of cable before and during installation shall be executed with regard to manufacturer’s recommendations. Cable drum shall be rotated only in the direction indicated on the drum, and open ends of cable shall be effectively sealed after cutting to prevent ingress of moisture, using heat shrink end caps.

1.24.7.5 Cable Pulling

a  HT cable shall be installed with the aid of specifically manufactured rollers, in order to prevent damage to outer sheaths.

b  Cable shall never be installed directly from a drum mounted on a moving vehicle.

c  Drum jacks, cable rollers, cable winch and other equipment shall be of the correct type for the cable being installed.

1.24.7.6 Cable Bending

a  At all times utmost care shall be exercised to prevent excessive bending or twisting of
b Cables shall be bent to a radius not less than 20 times the overall diameter.

1.24.7.7 Cable Installation

a Installation of direct buried cables shall not be commenced until the entire route has been excavated and prepared ready to receive the cable.

b If cable is left exposed above ground, it shall be coiled and suitably protected against damage. Alternatively, such cable may be left on the drum, which shall be lowered from its jacks and firmly anchored.

c Laying patterns, as indicated on the layout drawings, shall be adhered to.

d Unavoidable crossings shall be made either in the cable cellar directly underneath the corresponding switchgear panel, or at the branching-off point of a particular cable from the main trench. Care shall be exercised to keep the whole installation tidy in these areas.

e Ends of hard-floored cable trenches, ducts or pipes shall slope down into surrounding soil, to avoid cable damage following possible settling of soil.

1.24.7.7. Above Ground

General Requirements:

Cables laid above ground shall be suitably protected to meet the approval of the Electrical Inspectorate and other Statutory Regulations. Cables run on wall, ceiling readymade masonry trenches shall be supported on trays/brackets fixed to wall ceiling in an approved manner. Spacers and saddles shall be rendered rustproof. Plastic identification tags shall be provided at the ends and along the length cable at 15 M interval. Identification tags should be made up of material Lead in case laid in under ground.

1.24.7.7. Underground Cables

General Requirements

a All excavation, cable protection, back filling and surface restoration and installation of cable markers, protection tiles and warning tape shall be in accordance with the Electrical drawings
b  Construction of cable trenches, their bedding and back filling shall be executed in accordance with Electrical Drawings.

c  Where excavations are required near footings, foundations, concrete floors, etc. earthwork under and in the vicinity of these excavations shall not be disturbed and all back fill shall be well consolidated.

d  Installation shall be so arranged that all trenches are excavated and back filled in a minimum period of time, care shall be taken to ensure that all cable’s. For a particular route are made available at site, before trenches are excavated.

e  When planning the excavation sequence for cable trenches, the contractor shall take care to not obstruct access.

f  Adequate safety precautions shall be observed at all excavations by the provision of safety barriers, warning notices, shoring, etc.

g  Cables installed under roads shall be in accordance with the Electrical Drawings. An additional number of pipes, 3 to 5, depending on space, shall be installed at normal cable laying depth to accommodate future cables.

h  Cables to be installed in underground ducts, conduits or pipes, shall be of type that incorporates a sheath and/or armour, suitably resistant to any mechanical damage likely to be caused during drawing in.

i  Underground cable routes shall avoid close proximity to pipe crossings and parallel pipe runs. Physical separation between cables and pipes shall be not less than 300 mm and cables should cross underneath pipes.

j  If a cable route is in close proximity to underground pipes carrying hot liquids or gases, or which are regularly steam cleaned, the pipe shall be insulated in order to limit its outside temperature to a maximum of 60º C. In these cases cables may be run above pipes.

k  Buried cables shall be identified with their full cable numbers, as detailed on the cable schedule, at both termination points. Cable number shall be embossed on a metallic strip and installed on cables using proprietary cable ties. Sample of which shall be approved before use.

l  Cable route and cable joint markers shall be installed visibly at ground surface level in accordance with the Electrical drawings.

m  When cable routing is not definitely indicated on a design layout drawing, the Contractor shall submit full details of his proposed routing to The Company Site Representative for approval. Routing details shall be shown clearly on the Contractor’s...
working drawings.

1.24.8 Cable Jointing

a Cables shall be run in continuous unbroken lengths. Any requirement for cable jointing shall be executed only with the approval of the Consultant/Client

b Fully trained workmen who have passed an approved course of instruction in such work for the operating voltage level concerned shall execute all cable jointing. The Contractor shall furnish written confirmation in this respect to the Consultant/Client.

1.24.9 Cable Termination

a Cable boxes for straight through or termination joint shall be in the form of “kits” with jointing instructions and literature / test certificate. The kit shall also carry the name of manufacturer, date of manufacture and expire date on the kit also size type and or cable for which suitable.

b All the cable termination accessories such as cable sockets, compression joint sleeves, conducting jelly's, cable glands reducing bushes and check nuts etc. shall be best quality available.

c Fully trained & competent workmen who have passed an approved course of instruction in such work for the operating voltage level concerned shall execute all work on the termination of cables. The contractor shall furnish written confirmation in this respect to the company Site Representative.

d Within terminal boxes, an adequate length of cable loop shall be provided to enable each cable core to be connected to any terminal, in accordance with the approved method of termination for each equipment.

e All connections at a cable termination shall be mechanically & electrically perfect and shall be protected against mechanical damage or any vibration liable to occur. They shall not impose any appreciable mechanical strain on fixing of the connection and shall not cause any harmful mechanical damage to the cable conductor or equipment. Conductors of cables shall be terminated in a manner suitable for the terminal arrangement of the equipment concerned.

f Prior to final connection, all cable shall be checked for continuity and insulation resistance and correct installation

g The appropriate check sheets shall be complete by the Contractor and accepted by the Consultant/Client, prior to final connection.
1.24.10 Testing

HT Cable shall be tested at site as follows:

a. H.T. Cable shall be tested upon installation with a 2500 V insulation Resistance tester and the following readings established:
   1. Continuity on all phases
   2. Insulation resistance.
      - Between Conductors
      - Between all Conductors and ground.

3. High pot test as per I.S. Standard after installation of H.T cable, before commissioning.

b. For each lot of cables the contractor shall supply a certificate issued by the manufacturer stating its origin, date of manufacture, constitution and standard to which it complies and the test certificate.

c. Before shifting of cable drums from the yard to the site, insulation resistance shall be carried out on the cable and readings recorded in the presence of the Engineer –In-charge.

d. No backfilling of trenches shall be done till the trench/sand padding/ cables are inspected and tested.

e. All tests shall be done and recorded in the presence of the Site representative.

f. All test readings shall be duly recorded and presented.

1.25 SPECIFICATION FOR INSTALLATION (ERECTION) OF DISTRIBUTION TRANSFORMERS

1.25.1 Scope
The following specification covers the installation of transformers required for the proposed Project.

1.25.2 Installation

The transformer shall be installed as per the set of record plans to be supplied by the manufacturer and as described IS: 1 0028 (Part 2) –1981

IS: 1 0028(Part 1) -1985 Code of Practice for selection, installation and maintenance of transformers: Part 1 : Selection

IS: 1 0028(Part 2) -1981 Code of Practice for selection, installation and maintenance of transformers: Part 2 : Installation

IS: 1 0028(Part 3) -1981 Code of Practice for selection, installation and maintenance of transformers: Part 3 : Maintenance

IS: 2026(Part 1 to V) Power Transformer

IS: 3639-1966 Power Transformers, fittings and accessories

IS: 2099 Bushings for alternating voltage above 1000V

IS: 5 - 1951 Colors for ready mixed paints and enamels

IS: 648 Non-oriented electrical steel sheets for magnetic circuits

IS: 1866 Code of practice for maintenance of insulating oil

IS: 2166 Guide for insulation co-ordination

IS: 6600 Guide for loading of oil-immersed transformers

Wherever Indian Standards are not available, the Transformer shall conform to relevant International Standard.
1.25.3 Lifting

Transformer shall be lifted by the lugs or shackles provided for the purpose, simultaneous use should be made of such lugs or shackles in order to avoid any imbalance in lifting. Where it is necessary to use jacks for lifting, the projections provided for the purpose of jacking shall be used. Jacks shall never be placed under valves or cooling tube. In certain circumstances jacks may be placed under stiffening curbs on the tank base.

1.25.4 Foundation and Other Requirements

The transformer shall be installed on a level concrete plinth, of size to accommodate the transformer in such a way that no person may step on the plinth, if necessary bearing plates of sufficient sizes and strength shall be provided. When transformer is fitted with rollers. Suitable rails or tracks shall be provided and when the transformer is in the final position, the wheels shall be locked to prevent accidental movement of the transformer.

2) Termination of HT cable on the HT side of the transformers and LT power cables on the LT side of the transformers is in the contractor’s scope.

3) The Automatic On Load Tap Changer (OLTC) should be mounted externally on a flange provided on transformer tank and shall have an independent oil filled chamber. While installation the oil in the changer tank shall not mix with oil in the main tank.

4) Inter connection cables between OLTC, RTCC, AVR Panel & Marshalling box is in contractor scope.

5) Installation of Remote Tap Changer Panel(RTCC) and Automatic Voltage Regulator(AVR) is in scope of contractor.

1.25.5 Earthing

All connections to earth and earthing of neutral shall be carried out in accordance IS 3043-1987.

Transformer neutral, core and tanks shall be earthed as specified.

In the case of aluminium conductors being used for connecting copper terminals on the transformers, suitable bimetallic type connectors should be used to prevent electrolytic corrosion.

1.26 SPECIFICATION FOR BATTERY AND BATTERY CHARGER
1.26.1 **Battery**

1.26.1.1 **General**

1. **The battery shall be Lead Acid / Sealed Maintenance Free type with Planate or tubular positive plates. The battery should confirm to IS : 1651**

2. **The plates shall be designed for maximum durability during all service including high rate of discharge and rapid fluctuation of load.**

1.26.1.2 **Construction**

a. **Each cell shall be assembled in the heat resistant, shock absorbing, robust, clear glass or hard rubber container with float type level indicator.**

b. **The cells shall be supported on porcelain insulator fixed on the rack with adequate clearance between adjacent cells.**

c. **The cell terminals posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion.**

d. **Separator between plates shall permit free flow of electrolyte. Separator hall be wood or other acid resisting materials. Proper arrangement to keep the end plates in position shall be furnished.**

e. **Sufficient sediment space shall be provided so that the cells will not have to cleaned out during normal life.**

f. **Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.**

g. **Positive and negative terminal posts shall be clearly and indelibly marked for easy identification.**

h. **Lead coated bent copper plate, tubular copper lugs, teakwood clamp, bolts, nuts, washers, etc. shall be furnished for connection of outgoing aluminum conductor’s cables.**

i. **The battery shall be shipped uncharged with the electrolyte furnished in a separate non-returnable container. 10% extra electrolyte shall be furnished to cover spillage**
1.26.1.3 Racks

i) The racks for supporting battery cells shall be constructed of suitable size M.S Angle / CRCA Sheet steel frame of self-supporting type with multi tier arrangement of batteries.

Numbering tags for each cell shall be attached on the racks.

ii)

1.26.1.4. Fittings And Accessories

Each battery shall be furnished complete with the following:-

1. First charge of electrolyte plus 10% extra
2. M.S / Sheet Steel racks with 3 coats of anti acid paints
3. Stand insulators 5% extra.
4. Cell insulators plus 5% extra
5. Cell inter connectors and end take-off
6. Lead-coated connection hardware plus extra
7. Cell numbering tag with fixing arrangements
8. Teak wood cable clamps with hardware
9. Two (2) extra cell
10. One (1) inter connector bolt wrench
11. One (1) hydrometer Syringe
12. One thermometer with specific gravity correction scale
13. One (1) Cell testing Voltmeter with leads

1.26.2 Battery Charger

1.26.2.1 General

a. The charger shall be natural air cooled, solid-state type with full wave, fully controlled, bridge configurations.

b. The charger shall be provided with automatic voltage regulation, current limiting, soft start features.
c Voltage shall be step less, smooth and continuous.

d The charger shall be self-protecting against all A-C and D-C transients and steady state abnormal currents and voltages.

e Voltage setters shall be provided for setting the output of the float boost charge. Setting shall be independent of each other so that setting of one voltage shall not require resetting the other.

f There shall be separate transformers for float and boost charger.

g Charger A-C input and D-C output shall be electrically isolated from each other and also form panel ground.

1.26.2.2 Construction

a The charger shall be free-standing, floor mounted with sheet steel enclosure with all access from the front.

b The panel shall conform to the degree of protection IP 42 minimum thickness of the sheet metal used shall be 2 mm.

c Access doors shall be with concealed hinges and neoprene gaskets. Ventilating louvers shall be covered with fine wire mesh.

d All equipment within the panels shall be arranged in the modular units and laid out with sufficient space for easy maintenance.

e Switches, meters, relays etc. shall be flush mounted on the front of the panels. Nameplates of the approved size and type shall be provided for all circuits and devices.

1.26.2.3 Charger Equipment

a All power diodes and control rectifiers shall be silicon type. Rectifier transformer shall be dry type, double wound, with copper conductor and class B insulation.

b Blocking diodes shall be fully rated and redundant so that failure of a single diode shall not incapacitate the system in any way.
c. Isolating switches shall be heavy-duty, load break type, operated by external handle with provision for padlocking in ON or OFF position.

d. Change over switch shall be 3 position, 4 pole, and load break type with 2 No+ 2 NC auxiliary contacts.

e. Contactor shall be air-break type with thermal overload relays being in built single-phase prevent or.

f. Fuses shall be HRC type and arranged for easy replacement. Semi conducting device fuses shall be fast acting.

g. Indicating lights shall be low-watt filament type with series resistor. Both lamps and lens shall be replaceable from the front.

h. Meters shall be 96 x 96 mm switchboard type, 250 deg scale, antiglare glass, + 2% accuracy with zero adjuster on the front.

1.23.2.4 Alarms

a. One (1) ten-point alarm facia shall be provided on charger panel, complete with proper actuating devices, circuitry and legends.

b. The arrangement shall be such that, on occurrence of a fault the corresponding window will light up and stays lighted until the fault is cleared and reset button is pressed.

c. Each time a window lights up, a master relay will get energized to provide group alarm signals for remote panel.

d. Following minimum annunciation shall be provided

1) A.C. supply failure *
2) D.C. voltage low*
3) D.C. voltage high*
4) D.C. system ground*
5) Charger overload*
6) SCR fuse blown
7) Filter fuse blown
8) D.C. output fuse blown
9) Alarm points marked with an asterisk(*) shall have electrically separate set of contacts wired up to the terminal block.
10) Alarm contact shall be rated 1A at 110 V D.C and 5 A at 240 V AC.

1.23.2.5 Outgoing Feeders

a) Each outgoing feeders shall be provided with double pole switch and with HRC fuses.

b) Outgoing feeders shall be located in separate module forming part of charger panel with separate cable alley for terminating outgoing cables

1.23.2.6 Lamp/Space Heaters/Receptacles.

i) The charger panels shall be provided with:
   - Internal illumination lamp with door switch
   - Space heater with thermostat control

ii) Lamp, heater circuits shall have individual switch fuse units

Requirements:

<table>
<thead>
<tr>
<th>A) Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Type</td>
</tr>
<tr>
<td>ii) Nos. of cells per Battery</td>
</tr>
<tr>
<td>iii) Battery nominal voltage</td>
</tr>
<tr>
<td>iv) Ten hour rating to 1.85 Volt/cell at 27 deg.C</td>
</tr>
<tr>
<td>v) Proposed method of working :</td>
</tr>
<tr>
<td>a) Float charging (normal)</td>
</tr>
<tr>
<td>b) Boost charging</td>
</tr>
<tr>
<td>(After complete discharge)</td>
</tr>
<tr>
<td>vi) Mounting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B) Battery Charger</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Charger</td>
</tr>
<tr>
<td>ii) Float charging current</td>
</tr>
<tr>
<td>iii) Type</td>
</tr>
<tr>
<td>iv) A.C. Input supply</td>
</tr>
<tr>
<td>v) Ripple content in charger dc output</td>
</tr>
<tr>
<td>vi) Outgoing feeder 10 Nos</td>
</tr>
</tbody>
</table>
1.27 SPECIFICATION FOR POWER FACTOR IMPROVEMENT SYSTEM.

1.27.1 Scope

This specification covers the design, material specification, manufacture, testing, inspection, delivery to site and installation & commissioning of Power Factor Improvement System and its associated accessories.

1.27.2 General

The Power Factor improvement system shall comprise of capacitors and associated switchgear and control gear as per the requirements.

1.27.3 Capacitors

a Power factor correction capacitors shall conform in all respects to IS: 2834-1981 (amended up to date) or BSS: 1650-1971 or VDE 0560 Part 4 or I EC:70: 1967.

The CPRI test certificates of the capacitors shall be submitted. The capacitors shall be suitable for 3 phase 415V, at 50HZ frequency and shall be available in three phase units. The capacitors shall be suitable for indoor use up to ambient temperature of 50 deg C. The permissible overloads shall be given below

b Voltage overload shall be 10% for continuous operation and 15% for 6 hours for 24 hour cycle.

c Current overload shall be 15% for continuous operation and 50% for 6 hours in 24 hours cycle.

d Overload of 30% continuously and 45% for 6 hours in a 24 hours cycle.

e Capacitors (Gas Filled) shall be hermetically sealed in sturdy corrosion proof, CRCA sheet steel containers. The capacitors shall be provided with suitable discharge devices to reduce the residual voltage from crest value of the rated voltage to 50V or less with in one minute after capacitor is disconnected from the source of supply. The loss in the capacitor shall be very low

f Each capacitor shall be interconnected by tinned copper bus bars with final connections to capacitor terminals by means of copper flexible to relieve insulator from mechanical stresses.
The terminals shall be brought out through Epoxy resin bushings. The terminals shall be provided with detachable covers on all terminals and live parts. The capacitor unit shall have earthing studs.

1.27.4 Tests

1. Capacitors shall withstand power frequency test voltage of 2500V A.C. for one minute. The insulation resistance between capacitors, terminals and containers when a test voltage of 500V D.C is applied shall not be less than 50 mega ohms.

2. The copies of the following type tests shall be submitted along with routine test certificates.

1.27.5 Test for Dielectric Loss Angle.

i) Test for Capacitors losses.

ii) Thermal stability test.

Test Certificates from relevant Authorities / Electricity Boards.

1.27.6 Capacitor Control Panel

The capacitor control panel shall generally comprise of following:

1) Main incoming switch fuse unit or ACB.
2) Power factor correction relay.
3) Step controller with reversing mechanism
4) Time delay and no-volt relays
5) Protection fuses
6) Contactors and switch fuses for individual capacitor banks
7) Change over switch for either manual or automatic operation.
8) Current Transformers
9) Power factor meter with protection fuses.
10) Indicator lamp and push buttons for each bank.
11) Construction: The capacitor control panel shall be of cubicle type and shall be fabricated out of 16 SWG sheet steel suitably rust inhibited and stove enameled. The panel shall have adequate space for mounting the capacitors. The panel shall be of dust and vermin proof construction. Panels shall be of dead front pattern and floor mounting type.
The technical specification and construction features of capacitor control panel shall be same as that of medium voltage power / motor control centers, except the back covers of the panel housing the capacitor banks.

The capacitor banks shall be mounted at the rear side of the cubicle panel in different tiers arrangement. The interconnection between the switches / contactors and capacitor banks shall be by means of suitably rated aluminum bus bars and / or PVC armoured cables.

1.28 TECHNICAL SPECIFICATION FOR LOW VOLTAGE SWITCHGEAR

1.28.1 Scope

The scope under this section covers Low Voltage Switchgear such as:

- Main LT Panel
- Power Distribution Boards (PDB's)
- Lighting Distribution Board (LDB)
- Utility Socket Distribution Boards
- Motor Control Center (MCC), if any

1.28.2 General Information

1) The equipment's shall be designed, manufactured and equipped with accessories in accordance with this specification and the applicable codes standards indicated below. Materials and components not specifically stated in this specification but which are necessary for satisfactory and trouble free operation and maintenance of the equipment shall be supplied.

2) The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service life as specified herein.

1.28.3 Codes And Standards

The equipment covered by this specification shall unless otherwise stated be designed, constructed and tested in accordance with the requirements of the Indian Electricity Act and Rules and latest revision of the following Standards.

- IS 375 - 1963 Arrangement of bus bars, main connection and auxiliary wiring
- IS 335 - 1993 Insulating coils.
IS 722  AC electricity meters

IS 1248 - 1968 Direct acting electrical indicating instruments

IS 13947 (Part Motor starters AC, for voltage not exceeding 1000 V (Part-4, Sec 1 4) – 1993 ) Direct on line AC starters.

IS 13947 (Part Degree of protection provided by enclosures for low voltage (Part :- I) 1) - 1993 switchgear and control gear

IS 2419 - 1963 Dimensions of panel mounted electrical indicating and recording instruments

IS 13947 (Part Circuit Breakers (Part 2) 2)-1 993

IS 2607 Air break isolators for voltage not exceeding 1000 Volts

IS 2705 (Part Current Transformers I,2 and 3)

IS 4201 Application guide for CT's

IS 13947 (Part Contractors for voltages not exceeding 1000 V AC or 1200 V DC. (part 4, Sec 4) -1993 1)

IS 3072 -1965 Installation and maintenance of switchgear

IS 3231-1965 Electrical relays for power system protection.

IS 13947 (Part Air break switches, air break dis-connectors and fuse (Part 3) combination 3) -1993 units for voltages not exceeding 1000 V AC or 1200 V DC.

IS 3842 Application guide for electrical relays for AC System

IS 4047 -1967 Heavy duty air break switches and composite units of air break switches and fuses for voltages not exceeding 1000 V
IS 3156 (Part Voltage Transformers 1, 2 & 3)

IS 13947 (Part General requirements for switchgear and control gear for (Part 1) voltages 1)-1993 not exceeding 1000 Volts

IS 4483 Preferred panel cut out dimensions for electrical relays

IS 5124 Induction motor starters, AC (voltage not exceeding 1000 V) installation and maintenance of code of practice

IS 5987 Selection of switches (voltage not exceeding 1000 V)

IS 6875 : Control switches for voltages up to and including 1000V AC & 1200 DC

IS 8588 Code of practice for thermostatic bimetals Part I general requirements and method of tests

IS 8623 Factory built assemblies of switchgear and control gear for voltages up to and including 1000 V AC and 1200 V DC

IS 8828 - 1996 Miniature air break circuit breakers for voltages not exceeding 1000 Volts


IS 13703(Part LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part I, General requirements 1):1993/ IEC 269-1 (1986) 15
LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part 2, fuses for use by authorized persons, Section 1, Supplementary requirements

Specifications for LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC

LV switchgear and control gear, Part I - General rules

LV switchgear and control gear, Part 2 - Circuit breakers

LV switchgear and control gear Part 3, Switches, dis-connectors, switch dis-connectors and fuse combination unit

LV switchgear and control gear Part 4, Contactors and motor starters Section 1, Electromechanical

LV switchgear and control gear Part 5, Control circuit devices and switching elements, Section 1 Electromechanical control device (All parts)

Specifications for distribution pillars for voltages not exceeding 1000 Volts DC (First Revision)

Dimensions of electrical indicating instruments

1.28.4 Design Requirement

1) The panels shall be of 600V grade suitable for the system short circuit capacity and rated current carrying capacities and shall comprise of following:

   - Incoming & outgoing feeders, starters
   - rs and feeders connections
   - indicators and wiring
   - steel enclosure

2) Panel fabrication drawings and control wiring diagram should be got approved in writing before taking up the manufacturing.
3) Switchboards shall be rated for minimum fault level as mentioned in data sheets / drawings.

4) Control power supply of the switchboards shall be 240 V, 1 Phase, 50 Hz AC supply tapped from the respective module itself.

5) The switchboards manufacturers shall apply all de-rating factors necessary to all components of the switchboards to comply with the conditions detailed in this specification.

6) The ratings of motors, control gears, Circuit Breakers etc furnished in the drawings are for tender purposes only. Any changes in the above will be intimated at the time of placement of purchase order or before fabrication of panels.

7) The panels shall be modular in construction and fixed type for all incoming & outgoing compartments except Air Circuit Breakers.

1.28.5 Constructional Features

The switchboard shall be:

a) Of the totally metal enclosed, indoor, floor mounted, free standing, cubicle type with extensible modular, dust and vermin proof, IP-52 for indoor and IP-55 with canopy & two doors construction for outdoor installation with 14SWG CRCA Sheet for Base Frame and doors and 16 SWG for partition sheets for sections and non-loading members

b) Made up of the requisite vertical sections, which when coupled together shall form continuous single front switch boards.

c) Readily extensible on both sides by the addition of vertical sections after removal of the end covers.

d) Provided front access to the feeders, bus bars and rear access to cable termination, cable alley etc

e) Each vertical section shall comprise: Framed structure of rolled / folded sheet steel channel section, of minimum 2 mm thick CRCA Sheet steel, rigidly bolted or welded together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, molded case circuit breakers, main horizontal bus bars, vertical risers and other front mounted accessories.

f) Each feeder totally enclosed, self sufficient with ACB/MCCB/SFU unit, meters, relay, indicators, interlocking doors, pad locking facility, labeled terminal block, engraved plastic
labels for feeder details etc. with maximum height of operating handle 2100 mm for Main Panel and 1750 mm for other panels and minimum operating height of 350 mm for all panels.

g) Each compartment shall be provided with a hinged door interlocked with switch/breaker housed inside the compartment so that door cannot be opened unless the switch/breaker is in ‘OFF’ position.

h) A cable chamber of minimum width 300 mm shall be provided for the cable end connections of power/control cables. The design shall ensure generous availability of space for ease of installation and maintenance of cables and adequate safety for working in one vertical section without having accidental contact with other live parts in adjacent section.

i) A cover plate at the top of the vertical section, provided with a ventilation hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

j) Front and rear doors shall be fitted with tight neoprene gaskets with easy operating type fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. The doors shall have concealed hinges. Removable screwed covers shall be provided on the rear of the cubicles.

k) A set of horizontal main bus bars shall be provided at the top or bottom as required.

l) The vertical bus bars shall be housed in separate fully enclosed chamber of min. width 300 mm and accessible from front and shall be tapped off from main horizontal bus bars.

m) All incoming/outgoing terminals of the individual feeders shall be provided with insulated shrouds to avoid accidental contact with live parts.

n) Circuit breakers, Switch Fuse Unit, MCCB, etc shall be arrangement in multitudes except for ACB which shall not be more then two in a single tier.

o) Covers and partitions shall be of minimum 16 SWG CRCA sheet steel, whereas doors and main frame shall be of min. 14 SWG CRCA sheet steel. All sheet steel work forming the exterior of switch boards shall be smoothly finished, leveled and free from flaws. The corners should be rounded.

p) All switches, push buttons etc. shall be operate table from the front and shall be flush / semi flush mounted. The apparatus and circuits shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.
q) Apparatus forming part of the switchboards shall have the minimum clearances as per relevant IS standards. Clearances shall be maintained during normal service conditions. Creep age distances shall comply to those specified in relevant Standards.

r) All bus bar insulating material shall be of DMC/SMC to withstand the effects of high humidity, high temperature, tropical ambient service conditions etc.

s) Foundation bolts and nuts for each panel shall be supplied along with the respective switchboard.

t) The lifting eyes for each shipping section and danger notice plates shall be provided for each switch boards.

u) Functional units such as circuit breakers and fuse switches

v) Seven metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

w) Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

x) Cable termination’s of one functional unit, when working of those of adjacent unit/units.

1) All covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access.

2) Provision shall be made for permanently earthing the frames and other metal parts of the switchgear by the independent connections.

3) Base channel of ISMC — 100 for Main L.T Panels

4) Base channel of ISMC — 75 for PDB’ and DB’s

1.28.6 METAL TREATMENT AND FINISH

1) All steel work used in the construction of the switchboards should undergo through seven-tank process treatment.
2 All surface to be painted including interior and exterior of panels, and other metal parts shall be chemically treated to remove all rust, scale, grease and other adhering foreign matters. All parts of the panels operating on 415 V shall be coated with two coats of highly corrosion resistant primer followed by two coats of synthetic enamel paint of SIEMENS GREY (RAL 7032) shade. The Panels in the shops operating on 380 V should be coated with two coats of highly corrosion resistant primer followed by two coats of synthetic enamel paint of DARK BLUE colour. The finish shall be mat finish.

3 The complete treatment, painting, and drying with compressed air operations shall be done in dry and dust free atmosphere.

4 Should finished paint chip off or crinkle during transit/handling/installation, the contractor shall arrange for repainting the equipment at site at his own cost.

1.28.7 Busbars

1 The bus bars shall be air insulated and made of high conductivity, Aluminum Conductor, complying with the requirements of grade E91 E of IS 5082 and suitable for 415 Volts, 4 wire, 50 Hz system and 380 Volts, 4 wire, 50 Hz system.

2 The bus bars and connections shall be suitably supported/ braced with non hygroscopic DMC/SMC supports to provide a fault withstand capacity as specified.

3 High tensile bolts and spring washers shall be provided at all bus bar joints.

4 The bus bars shall be liberally sized and shall have uniform cross section throughout, and shall be capable of carrying the rated current at 415 V and 380 V continuously with color coded PVC sleeves with minimum 40% derating of bus bar sizes I amperage declared by busbar manufactures of reputed make i.e. I Amp = 1.1 sq.mm Aluminium in Main L.T.panel and 1 Amp = 0.8 sqmm in PDB’s.

5 Branch busbars rated for 75% of aggregate capacities of feeders connected. - Neutral bar : % of phase bar. - Earthing bar : 50% of phase bar.

6 All bus connections, joints and taps shall be short and as straight as possible, and applied with contact grease in the mating surface.

7 The main horizontal bus bars shall be run through the entire length of the panel and shall be accessible for maintenance from the front as well as rear. Bus bar chamber shall have separately screwed covers. All bus bars, links etc. shall be provided with insulating cover to prevent accidental contacts. The natural bus bars shall have a continuous rating of at least 50% of the phase bus bars.
8 Bus bars shall be encased in color coded heat shrunk PVC sleeves (snug fit type). An aluminum earth bus of size not less than 75 x 10 mm shall run through the length of switch boards at top or bottom as required.

1.28.8 Air Circuit Breakers

1) The ACB’s shall be double break, quick make, quick break, trip free horizontal draw out electrically/manually operated type and shall comply the following features fixed type ACB’s above 630A are not acceptable.

2) The breakers shall comply with the requirements of IS 13947 (Parts II & II/ Sec. I) -1977 Short Circuit Performance Category P 2, ICE 60947 (Part -1&2)and shall have:

3) A short circuit breaking capacity of not less than 50 KA, RMS at 415 Volts 50 Hz AC.

4) A short circuit making capacity of 105 KA.

5) A short time withstands circuit of 50 KA for 1 second.

6) Mechanical and electrical endurance for 2000 operating cycles out of which 100 cycles should be for electrical endurance.

7) Electrical overload performance at 6 times the rated current, 110% of the rated voltage as recovery voltage and 0.5 power factor. Dielectric test of 2.5 KV applied for one minute on main circuits.

8) Test evidence from a recognized independent Laboratory / Institution shall be furnished for compliance of the breakers with the above requirements.

9) The circuit breakers shall be fitted with detachable arc chutes on each pole designed to permit rapid dispersion, cooling and extinction of the arc. Interface barriers shall be provided to prevent flash-over between phases.

10) Arcing contacts shall be of hard wearing material of copper tungsten or silver tungsten and shall be readily replaceable. Main contacts shall be of pure silver of high-pressure butt type of generous cross section.

11) The operating mechanism shall be of robust design, with a minimum number of linkages to ensure maximum reliability. Manually operated circuit breakers shall be provided with spring operated closing mechanism, which are independent of speed of manual operation. Electrically operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring.
12) The operating mechanism shall be such that the breaker is at all times free to open immediately the trip coil is energized.

13) Mechanical operation indicators shall be provided to show open and closed position of the breaker. Electrically operated breakers shall be additionally provided with mechanical indications to show charged and discharged conditions of the charging spring.

14) Means shall be provided for slow closing and opening of the breaker for maintenance purposes, and for manual charging and closing of electrically operated breakers during emergencies.

15) Provision shall be available for fitting a minimum of five trip devices three over current, a shunt trip and an under voltage release or two over current, and earth fault release, a shunt trip and one under voltage release. The breakers shall be of the shunt or series trip type as specified. For static trip device either a shunt trip or an under voltage coil shall be provided.

16) Circuit breakers shall be individually housed in sheet metal cassettes provided with hinged doors. The breaker along with its operating mechanism shall be mounted on a robust carriage moving on guide rollers within the cassette. Isolating contacts for both power and control circuits shall be of robust design and fully self aligning. The assembly shall be designed to allow smooth and easy movement of the breaker within its cassette.

17) The breaker shall have three distinct positions within the cassette as follows
   a) 'Service' position : with main and auxiliary contacts connected.
   b) 'Test' position : with power contacts fully disconnected and control circuit contacts connected
   c) 'Isolated' position : with both power and control circuit contacts fully Disconnected.

18) It shall be possible to achieve any of the above positions with the cassette door closed. Mechanical position indicators shall be provided for the three positions of the breaker.

19) The moving portion of the circuit breaker shall be so interlocked that :
   a) It shall not be possible to isolate it from the connected position, or to plug it in from the isolated position with the breaker closed.
   b) The circuit breaker can be closed only when it is in one of the three positions or when it is fully out of the cassette.
23) Inadvertent withdrawal of the circuit breaker too far beyond its supports is prevented by suitable stops.

24) Moving portions of breakers of the same ratings shall be interchangeable.

25) Provision shall be available for the padlocking of the circuit access flaps in any of the three positions.

26) Automatically operated safety shutters shall be provided to screen the fixed isolating contacts when the breaker is drawn out from the cassette.

27) The moving portion of the circuit breaker shall be provided with a heavy duty self aligning earth contact, which shall make before and break after the main isolating contacts during insertion into and withdrawal from the service position of the breaker. Even in the isolated position positive earthing contact should exist.

28) Auxiliary switches directly operated by the breaker operating mechanism and having 4 NO and 4 NC contacts, shall be provided on each breaker. The auxiliary switch contacts shall have a minimum rated thermal current of 10 Amps.

1.28.9 Protection Device

Breaker shall be provided with CT operated Digital Protection against Overload, Short Circuit and Ground fault. (Earth Fault).

a) Overload Protection – The release shall provide inverse time-current characteristics against over load and shall be adjustable from range of 50% to 100% of the normal current. It shall also be suitable for three different trip timer 2.5 second, 13 second, 25 second at the six time the rated current.

b) Short Circuit Protection- The release shall provide a wide range of protection against Shot Circuit Condition

   (i) current Continuously adjustable for 2 to 10 times the normal current.

   (ii) Time delay Continuously adjustable form instantaneous to 400 m sec.

c) Ground Fault protection - The Time delayed protection against ground fault. The device shall have current and ‘Time delay’ adjustable continuously from a range of 0.2 to 0.5
time the normal current and 100 m sec to 400 m sec respectively.

d) Under Voltage Release:- Breaker shall also provided with “Under Voltage release” to trip the system on low system voltage. It shall be of type MVR with a built in time delay of 3+1 Sec to prevent undesirable tripping of breaker in case of volt-drips due to transient faults. It shall be suitable for 415V,50 Hz with range of operation as

(i) Pickup :-80% of standard voltage

(ii) drip Off from 35% to 65 % of standard voltage.

1.28.10 Moulded Case Circuit Breakers

1) The MCCB shall be complying with IS: 13947 Part II& III and ICE -60947(Part 2).

2) MCCB’s shall be triple pole (TP) / four pole (FP) Thermo-Magnetic / Micro Processor based releases with quick break and quick make type and shall be trip free.

<table>
<thead>
<tr>
<th>Capacity of MCCB</th>
<th>Ultimate Breaking Capacity</th>
<th>Overload Range</th>
<th>Short Circuit Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 125 Amps</td>
<td>16KA</td>
<td>Adjustable thermal Release (0.7 to 1.0 in)</td>
<td>Fixed magnetic type suitable for 10.0 In</td>
</tr>
<tr>
<td>160 or 250 Amps</td>
<td>36KA</td>
<td>- do- but range from 0.64 to 1.0 In</td>
<td>Adjustable thermal magnetic release (3.5 to 10.0 In)</td>
</tr>
<tr>
<td>400 and 630 Amps</td>
<td>36KA</td>
<td>Electronic release with over load zone of adjustment 0.4 to 1.0 In</td>
<td>Electronic release with Short circuit zone of adjustment 1.5 to 10.0IR (Adjustable current) with Time</td>
</tr>
</tbody>
</table>

3) Short circuit withstanding capacity shall be as indicated in the respective drawings.

4) The insulating case of the MCCB’s shall be made of high strength heat resistant, flame retardant and thermosetting material so as to provide the following important functions;

a) Safety of operating personnel.

b) High withstanding capacity against thermal and mechanical stresses

c) Very high dielectric strength

5) The contact system shall be maintenance free with arc extinguishing devices & Properties.
7) **Visual Indications:** The following visual indications shall be provided for the MCCB’s
   a) “O N”
   b) “O F F”
   c) The MCCB’s shall have adjustable/fixed thermal overload setting and adjustable/fixed magnetic setting as per the drawings or specifications

8) The MCCB’s shall be of manual type as per the requirements indicated in the drawings and specifications.

9) Minimum one No. (1 No.) NO / NC / Change Over auxiliary contact shall be available for “ON” & “OFF” positions.

10) For 4 pole MCCB’s, the neutral contact shall make earlier than the phase but while tripping, the neutral contact shall break later than the phase for safety purposes.

11) Positive indication of neutral shall be available standard accessories.

The following accessories shall be a standard feature of the MCCB
   a) Rotary handle operating mechanism with locking arrangement as indicated in the drawing & specifications

1.28.11 **Switches And Switch Fuse Units**

The switches and Switch Fuse units shall be of AC 23 duty and shall comply the following features:-
   - Quick make, quick break, double break silver alloy contacts with arising horns or chutes.
   - Common operating handle with door interlock feature.
   - HRC cartridge fuses suitable for breaking system fault levels and with visible indication.
   - Switch fuse units of combination fuse switch type with fuses on phase circuit and copper solid links for neutral circuit for TPN and OP units.

1.28.12 **Relays**

   a) Wherever the relays external to ACB’s are specified, they shall comply the following features:
c) Instantaneous earth fault having 2D-80% setting.

d) Direct acting trip coil to suit 5A CT secondary and with time delay dash pot or TC fuses.

e) Shut trip coils to have necessary DC power source with associated charger.

f) Discrimination of operating characteristics for trips and delay elements with up and down streams switchgear.

g) Testing of relays by primary injection and secondary injection.

h) Enclosed in dust proof flush mounting draw out type cases.

i) Accessible for setting and resetting from the front.

j) Provided with positive acting hand-reset flag indicators visible from the front.

k) Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be eternal to the case.

l) Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage

m) Each relay shall be provided with at least two separate voltages from contacts

n) Make and type of relays shall be as approved by the Engineer.

1.28.13 Starters

The starters for rotating machines shall be as follows:-

- Below 7.5 KW : Direct on Line
- 7.5 & above to 200 KW : Star Delta
The starters shall comply the following features:-

a Main and auxiliary contacts of required capacity with coils and 2 nos. NC and NO spare contacts each.

b Automatic change over for star delta with adjustable thermal timer.

c Bimetallic over load relays and single phase prevention relays.

d Illuminated start stops push buttons with latch.

e Internal wiring and accessories including CT’s wherever required.

1) Contactor

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor starter contactors shall be of silver plated copper.

Each motor-starter contactor shall be provided with two NO and two NC auxiliary contacts.

Insulation class of operating coils shall be class B or better.

Operating coils of contactors shall be suitable for operation from the specified contra supply system.

Contactors shall be of the double break, non-gravity type.

One number spare auxiliary with 4 NO/4 NC contact along with its cad. Completely wired up to the terminal should be provided.

2) Direct-On-Line Starters

Direct-on-line starters shall be suitable for Class AC 3 utilization category.
Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.

Reversing starters shall be suitable for Class AC 4 duty.

4) Thermal Overload Relays

Starters shall be complete with three elements, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The settings range shall be properly selected in accordance with the rating of the motor.

Thermal overload relays shall be hand-reset type.

Stop’ push button of the starter and hand-reset device shall be separate from each other.

Overload relay hand reset push button shall be brought out on the front of the compartment door.

Overload relay shall be provided with at least one ‘NO’ and one ‘NC’ or one changeover contact.

5) Transformers for Control pace Heating & Annunciator Supplies

Adequately rated single phase, two winding, dry type transformers shall be provided for providing supply to the switchgear control and alarm circuits, space heaters provided in plant equipment and space heaters in the switchgear and motor winding heating circuits.

A separate control transformer shall be provided in each module to cater for that particular module. Common control transformer rating shall be adequate to cater for all the control equipment connected across it. For control transformers in each module, the minimum rating shall be as follows:

<table>
<thead>
<tr>
<th>Motor Rating</th>
<th>Control Transformer Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>kW</td>
<td>VA</td>
</tr>
<tr>
<td>Up to and including 30</td>
<td>75</td>
</tr>
<tr>
<td>Above 31</td>
<td>300</td>
</tr>
</tbody>
</table>

All transformers of 500 VA and above shall be controlled by switches on the primary side.
Control transformer in individual module shall have fuse in the line lead of only secondary winding. The fuses shall be of proper rating to protect the control transformers against overloads and short circuits. The neutral or the earth lead shall have earth link instead of fuses.

Control and Selector Switches:

Control and selector switches shall be:

a) **Rotary type**

b) Adequately rated for the purpose intended (Minimum acceptable rating is 10 A continuous at 240V AC and 1A inductive break) 220V DC

c) Provided with plates clearly marked to show the positions

Control switches for circuit breakers shall be provided with pistol grip type handles.

Control switches for circuit breaker control shall be provided with:

a) Contact development and sequencing device.

Selector switches shall be:

a) Of the maintained contact stay put type. Switches in ammeter circuits shall have make-before-break type contact.

b) Provided with oval handles.

Push Buttons

Push button shall be:

a) of the momentary contact, push to actuate type rated to carry 1 0A at 240V AC and 1A (inductive breaking) at 220V DC.

b) fitted with self reset, 2 NO and 2 NC contacts.

c) Provided with integral escutcheon plates marked with its function.

‘Start’, ‘Open’, ‘Close’ push buttons shall be green in colour.
All other push buttons shall be black in colour.

‘Emergency Stop’ push buttons shall be lockable in the pushed position type and shall be shrouded to prevent accidental operations. Key shall not be required for the operation of the push buttons.

1.28.14 Current Transformers

Current transformers shall comply with the requirements of IS 2705(Part 1, 2 and 3). They shall have ratios, outputs and accuracy's as specified / required.

1) Current transformers wherever required and called for in the single line diagram and/or required shall be furnished.

2) The CT’s shall be primary, in epoxy moulded base mounted and comply the following features:
   Class I accuracy for metering and Class 1 and 5 p 10 for protection with rated burden of 15/30 V on secondary.

3) Error limit to specific class of accuracy.
   Air or epoxy resin insulated with bar or wound type.

The CT’s shall be designed to withstand the thermal and mechanical stresses resulting from the Maximum short circuit current.

The vendor shall ensure that the VA output of the CTs are adequate for the relays, meters and loads connecting them.

4) The CT’s shall be provided with Class A/Class B insulation and proper polarity markings in a suitable manner.

5)

6) 1.28.15 Meters and Indicators

The meters and relays shall comply the following:

a) MISC type with Class-I accuracy.

b) Ammeter, Voltmeter, trivector meter with recorder, PF meter should be electronic digital type compatible to PC.
d) Maximum demand electronic meters trivector with integration time of minutes, wherever specified.

6) 

e) Energy and demand meters to be tested by local supply co.

8)

1.28.16 Indicating Lamps (Led Type)

LED indicating lamps shall be provided wherever called for in the control schematic diagrams. The lamps assembly shall be complete with cluster of LED’s, holders and lenses.

11) 

1.28.17 Fuses

All control and power fuses shall be HRC fuses and they shall be provided with visible indication to show that they have operated.

1.28.18 Cable Terminations

1) Cable entries and terminals shall be provided in the switchboard to suit the number, type and size of Aluminum conductor power cables and copper conductor control cable specified in the detailed specifications.

Switchboard shall be designed either for top or bottom or combined entries and outgoings, which Consultant/Client will confirm at the time of drawing approval. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Removable un-drilled plates shall be furnished for fitting the cable glands.

Sufficient space shall be provided to avoid sharp bending and for easy connection. A minimum space of 300 mm from the gland plate to the nearest terminal block shall be provided.

3) Multi way terminal blocks complete with screws, nuts, washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

4) Power and control terminals shall be washer head screw type or stud type complete with crimping type connectors. Screw type terminals with screws directly impinging on conductor are not acceptable.

5) Each control terminal shall be capable for connection of 2 Nos. 2.5 mm standard copper wires at each ends.

Not more than two wires shall be connected to any terminal. If necessary a number of terminals shall be jumper
At least 20% spare terminals shall be provided in each module.

Terminal blocks for current transformer secondary lead wires shall be provided with shorting and Earthing facility. Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

10)

11) 1.28.19

Wiring

1) The wiring shall be complete in all respects so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be completed up to terminal blocks on the side of each unit module.

2) All control wiring shall be carried out with 1100/660 V grade single core PVC cable having stranded copper conductors of minimum 2.5 Sqmm.

3) Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wires shall not be spliced or tapped between terminal point.

Numbered ferrules at each end shall identify wires. The ferrules shall be of the ring and of non deteriorating material. They shall be firmly located on each wire so as to prevent free movement, and shall be interlocking type.

5) All control circuits to be controlled by MCB’s and shall be mounted in front of the panel and shall be easily accessible.

6) All spare contacts of relays and switches shall be wired up to the terminal blocks.

8) Each of the DC circuit shall be provided with two fuses one in the positive and the other in the negative for 2 wire DC underground system of specified voltage.
1.28.20 Ground Bus

1) An aluminum ground bus rated to carry maximum fault current shall be furnished along the entire length of each switchboard. Each stationary unit shall be connected directly to this ground bus by two separate and distinct connections in accordance with Indian Electricity Rules.

Grounding terminals on the ground bus shall be provided. Connectors shall be provided at either end of switch board for connection to station ground mat.

1.28.21 Terminal Blocks

Terminal blocks shall be of 660 Volts grade of stud type. Insulating barriers shall be provided between adjacent terminals.

1) Suitable provision shall be made to terminate control/power connections in the respective module.

2) Terminal blocks shall have a minimum current rating of 10 Amps and shall be shrouded.

1) Provisions shall be made for label inscriptions. The wire terminations to the blocks shall be of screw type suitable for crimp type socket

1.28.22 Name Plate

1) The panel as well as feeders compartments shall be provided with name plate of anodized aluminum, with white engraving on blue background. They shall be properly secured with self-tapping screws at the top of the cubicles. The panel/feeder descriptions shall be as indicated in the drawings/employers. The size of the nameplates shall be proportionate to the respective equipment’s.

Also individual panel number and danger plate shall be furnished at back of panel.

2) 

1.34.23 Accessories

The following accessories shall be furnished along with each switchboard.

a) One (1) no. fuse pulling handle for each switchboard.
b) One (1) no. winding handle for withdrawing breaker from the cubicle.
c) Other accessories as deemed necessary for trouble free and efficient operation of the equipment offered.
1.28.24 Drawings And Manuals

The following drawings shall be supplied for each switchboard.

General arrangement drawing for each type of board showing constructional features and space required in the front for withdrawal of breaker, power and control cable entry points, location of various devices, terminal blocks, cross sectional details, bus bar supports, number of buses, etc. shall be submitted within 15 days from the date of letter of intent for approval.

Foundation plan and anchor hold details including dead load and impact load.

Drawing and data sheet for each component.

3) 3)

Electrical wiring diagram.

Terminal block arrangement drawing for outgoing feeders.

4) Complete relay technical particulars and recommended settings.

5) Operation, maintenance and installation manuals.

6) Technical Catalogues /Leaflets of CTs, meters, lamps, etc. shall be submitted along with Offer.

7) The approval of the drawing does not absolve the vendor from his obligation of ensuring proper and correctness of functioning / operation of the system.

9)
bolts for each division of Transport. The cable shall be terminated into the panel through glands fixed to bottom/top plate. The panel shall be bonded to the earth by connecting leads to the panel earth bus.

1.28.26.2 Handling/Unloading

Switchgears and all its accessories shall be handled/unloaded carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear. While using jacking pads utmost care shall be taken in proper application of jacks. Where switchgears is dragged or pulled on sleeper or rollers of the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles. Unloading from the lorry shall be carried out using a mobile crane or tripod with chain pulley block or rolling over to a platform.

1.28.26.3 Storage

Equipment's shall be stored under shelter in a well-ventilated, dry place and covered by suitable polythene or tarpaulin covers for protection against moisture.

1.28.26.4 Erection

Panels shall be installed over a trench. The panels shall be aligned properly and bolted to the flooring by at least four bolts. The cables shall be terminated into the panel through bottom plate. The panel shall be bonded to the earth by connecting earthing leads to the panel earth bus.

1.28.26.5 Tests

The L.V switchgear shall be subjected to factory inspection before finishing and dispatch unless inspection is waived. The following preliminary checks and Pre-commissioning tests shall be carried out before commissioning the Switchgears in the presence of Consultant/Client.

1.28.26.5. Preliminary Checks

1. Check nameplate details according to specification.
2. Check for physical damage.
3. Check tightness of all bolts, clamps and connecting terminals.
4. Check oil level air pressure and leakage (wherever applicable)
5. Check earth connections.
Precommissioning Checks

1.28.26.5.

2 1. Check alignment of breaker trucks for free movement. Check correct operation of shutters.
   2. Slow closing/opening operation
   3. Check control wiring for correctness of connections, continuity and IR values.
   5. Power closing/opening operation manually and electrically
   7. Trip free and anti pumping operation.
   8. I.R. values, resistance and minimum pick up voltage of coils.
   9. Contact resistance.
  10. Simultaneous closing of all three phases.
  11. Pole discrepancy tests.
  12. Single and three phase auto reclose operation.
  13. Check electrical and mechanical interlocks provided.
  14. Check on spring charging motor correct operation of limit switches and time of charging
  15. Check on C.T’s
  16. All functional checks with the relays, meters, alarm scheme, interlock as per scheme with primary injection kits.
  17. Inspection of the switchboards including inspection of wiring and electrical operational tests.

1.28.26.5. Routine and Type Test

3 a. Routine test certificate for ACB’s, MCCB’s, SFU’s, meters, CT’s, relays, starters etc from manufacturer.

b. Insulation Resistance Tests Insulation resistance test with 1000V meggar with all switchgear in closed position.
   Phase to Phase : 2.6 meg. ohms.
   Phase and Neutral : 1.5 meg. Ohms.

c. Secondary wiring and apparatus should withstand 2000V for one minute.

d. Meters and relay calibrated and tested through secondary injection tests
e. Continuity test

f. Operation test

g. Type test certificate for busbars from CPRI or government recognised test laboratory.

h. **HIGH VOLTAGE TEST:**
   
   High voltage test with 2.5 KV for one minute shall be applied between the pole and earth. Test shall be carried out on each pole in turn with the remaining poles earthed. All units racked in position and the breakers closed.

i. Originals test certificate shall be submitted along with panel.

1.29 **SPECIFICATION FOR POWER AND LIGHTING DISTRIBUTION BOARDS**

1.29.1 **Scope**

The scope under this section covers light and power distribution boards.

1.29.2 **Standards**

- **IS 8623**: Factory built assemblies of switch gear and control gear for voltages up to and including 1000V AC and 1200 V DC.

- **IS 8828**: Miniature circuit breakers for voltages not exceeding 1000 Volts

- **IS 2675-1966**: Specification for enclosed distribution fuse boards and cut outs for voltage not exceeding 1000 Volts

- **IS 2208**: HRC cartridge fuse links 650 Volts

- **IS 732**: Code of practice for electrical wiring installation

- **LS:2607-1 976**: Air break isolator for voltages not exceeding 1 000V

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**

**IS: 5578-1985**: Marking and arrangement of switchgear busbars, main connections and
auxiliary wiring

IS: 8828-1996 : Miniature circuit breaker

IS: 12640 – 1988 : Earth leakage circuit breaker

Moulded Case Circuit breaker


IS:13703(Part 2- Section 1): 1993/ IEC-269-2(1 993) LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part 2, fuses for use by authorized persons, Section 1, Supplementary requirements

IS:13703(Part 1 to 4) 1993 Specifications for LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC

IS 5093 : 1983 Specifications for distribution pillars for voltages not exceeding 1000 Volts DC (First Revision)

IS : 2419 : 1962 Dimensions of electrical indicating instruments
1.29.3 Type And Construction

The distribution boards shall be complete with:

a. Sheet steel enclosure suitable for recessed, semi-recessed or surface mounting on wall/structure.

b. Busbars, incoming and outgoing feeders.

c. Earthing terminals.

d. Circuit diagram indicating load distribution.

1.29.4 Enclosure and fabrication

The fabrication the enclosure shall comply the following:

a) 16 SWG, sheet steel enclosure.

b) Wire race for individual phases.

c) Phase barriers of insulating materials for LDB's

d) Phase indicating lamps for incoming feeders

e) 2 Nos Earthing terminals.

All the Distribution Boards are of double door type with top door of acrylic type and with IP 40 Degree of protection.

The main switch and outgoing shall have rating as specified in the drawins and schedule. The boards shall be designed to have adequate cabling space for either top or bottom entry of both incoming and outgoing cables.

1.29.5 Bus Bars

1) Suitable color coded bus bars made of high conductivity aluminum/copper bus bars suitable for incoming feeders with 1 A= 0.8 sq.mm for aluminium and 1A= 0.7 sq.mm for copper and mounted on non hygroscopic insulating supports shall be provided. Neutral bus bars and earth bus bar shall be of half the size of phase bus bar.

2) Individual phase and neutral bars located in respective phase cubicle for LDB's.

1.29.6 Miniature Circuit Breakers

1) Miniature circuit breakers shall have a minimum breaking capacity as mentioned in the BOQ

2) Circuit breakers shall be equipped with individual insulated, braced and protected connectors.
3) The front face of all the breakers shall be flush with each other. The breakers shall have 'quick break trip free' mechanism with current limiting and overload and short circuit tripping characteristics. The mechanism shall be such that the circuit cannot be held closed when a fault occurs or persists.

4) The contacts shall be silver tungsten or other suitable material to give long contact life. Multiple units shall have an inter tripping mechanism thereby ensuring complete isolation in the circuit in the event of an overload or fault in anyone of the phases. The connectors shall be suitably shrouded.

1.29.7 Safety & Interlocks

1 All the live parts are shrouded such that accidental contacts with live parts are totally avoided.

2 Distribution boards shall be provided with a front-hinged door. Distribution boards interior assembly shall be dead front with the front cover removed. Main lugs shall be shrouded. Suitable insulating barrier made of arc resistant material shall be provided for phase separation. Ends of the bus structures shall also be shrouded.

1.29.8 Cabinet Design

1 The distribution board cabinet shall be totally enclosed type with dust and vermin proof construction.

2 The interior components shall be mounted on a separate sheet, which is mounted and locked on to the studs provided inside the cabinet. Over this, a cover made of acrylic door shall be provided.

3 Cabinets shall have 25mm knock out detachable glands plates at both top and bottom and sides. Robust fasteners enabling dust protection gasket to be compressed quickly and easily should secure the door. Unless specified otherwise boards shall be flush mounted in walls.

1.29.9 Terminals

Distribution boards shall be provided with a terminal block of adequate size to receive mains incoming cable and outgoing circuits. The location of the terminal block shall be so located that crowding of wires in the proximity of live parts is avoided. A neutral link having rating equal to that of phase bus shall be provided.
Distribution boards shall be provided with a directory indicating the description of loads served by such circuit breaker, the rating of breakers, size of conductors, etc. The directory shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door. The DB’s shall be provided with inscription plates. The size of letters shall be as approved and the wordings for inscription shall be given by Consultant/Client.

1.29.11 Installation

1. Distribution boards shall be surface mounted or recessed mounted as required by the Consultants/Client and at the locations shown on the drawings. The boards shall be fixed with suitable angle iron clamps and bolts.

2. All the cables/conduits shall be properly terminated using glands/grips/check nuts, etc. Wiring shall be terminated properly using crimping/lugs sockets and PVC identification ferrules. The DB’s shall be installed as specified in IS 732 and National Building Code.

1.29.12 Fasteners

All the screws, nuts, bolts, washers, etc. used for the current carrying parts shall be of brass or other approved non ferrous material. Other fasteners shall be made of non corroding materials. The screws used for fixing the top plate and the washers shall be of MS with nickel-plated.

1.29.13 Testing

Distribution boards shall be tested at factory as per Indian Standard.

1. HV test at 2.5 KV for 1 minute.

2. Insulation resistance shall be tested with 1000 V megger and the values should be as shown below:
   
   Between Phase : 2.6 meg ohms.

   i) Between Phase and Neutral : 1.5 meg ohms.

1.29.14 Drawing Approval

The contractor shall submit the drawings for approval before fabrication of the panels.
1.30.1 Scope

The following specification flameproof Distribution board, flameproof illumination fixtures, flameproof exhaust fans, flameproof switch with cable termination box, flameproof switch sockets and plugs for the proposed Project.

1.30.2 General Information

The intent of this specification is to define the requirements of Utility Boards, Power Distribution Board, Light Distribution Board, Lighting fixtures and control gears, plug sockets, DP switch, Exhaust fans, junction boxes, FRLS cable, cable glands, lugs, motors etc suitable for installation.

All electrical components forming part of electrical distribution system requires to be manufactured & tested as per IS 2148. The scope of supply of items under this contract.

1.30.3 Code and Standards:

The Flameproof fixtures shall conform to the requirement of the latest revisions of the following Codes & Standards.


IS 4012 / 1967 : Dust proof electric light fittings

IS 4013 / 1967 : Dust tight electric light fittings


Intrinsically safe magneto telephones for use in hazardous atmospheres.
Bolted flameproof cable couplers & adaptors

IS 6789 / 1972

IS 8224 / 1976 Specification for lighting fittings for Division 2 areas

IS 8945 / 1987 Specification for electrical measuring instruments for explosive gas atmospheres

IS 9099 / 1980 Part II: Performance testing of powered industrial trucks working in hazardous areas (battery operated)

IS 9628 / 1980 Three phase induction motors with type of protection ‘n’

Wherever Indian Standards are not available, the transformer shall conform to relevant International Standard.

1.30.4 Design Criteria

1) Layout of illumination fixtures, exhaust fans, and switches shall be as per drawing

2) The Distribution Board, light fixtures, Plug socket, DP switch, Cable and junction boxes along with accessories, shall be certified conforming to applicable standards by a competent authority like CMRS Dhanbad/CCE Nagpur-India or equivalent from the country of origin.

3) All light fixtures and junction boxes along with accessories shall have weatherproof enclosures (IP-55/NEMA-4 or equivalent) and suitable for the hazard in which they are installed. The temperature class shall be T3 as per IEC, unless otherwise specified. The body of the DB/fixture/junction box shall be cast metal and shall be free from frictional sparking hazard

4) All fixtures shall be provided with sheet steel vitreous enameled or approved type reflector. All light fixtures except flood light fixtures shall be provided with steel wire protective cage having mesh dimensions of 50 mm x 50 mm. The glass used shall be clear and toughened type suitable for use under conditions involving exceptional risk of mechanical damage.

The light fixtures shall have glass sealed into retaining ring, which, in turn, shall be
The fixtures shall be suitable for mounting on poles/ceilings/columns. Suitable fastening devices such as Clamps/brackets etc required for installation shall also be supplied. All hardware such as nuts, bolts, washers etc. shall be cadmium plated. All the fixtures shall be provided with an internal earthing terminal.

Special tools, if required, shall also be provided. All the fixture nameplates shall bear the stamp of certifying agency

5) The junction boxes, wherever required, shall be flame proof and shall be provided with cable termination accessories for copper / Aluminium cables. All terminals for cable connection shall be anti-loosening type.

An earthing terminal shall be provided inside the junction box. Sufficient space for accommodating specified numbers of cables and easy access to their terminals for termination purposes shall be provided. Four lugs shall be provided for mounting of junction box on wall/steel structure.

6) Flame proof, double compression type, nickel/chromium plated brass cable glands shall be provided for all flame proof equipment. The lugs provided shall be tinned copper crimping type.

7) All equipment shall be painted as per general specification.

8) Testing and inspection of light fixtures and Junction boxes shall included but not necessarily be limited to the following:
   a) A visual inspection shall be made to ensure that the finishing and workmanship are up to the mark.

   b) Company reserves the right to witness the final testing and inspection. Prior intimation of at least 7 days shall be given to enable the Company to depute its representative to witness the test.

9) Erection / installation of distribution board, fitting, cabling and jointing / termination shall be in accordance with the Standards stipulated for flameproof characteristics. The contractor shall arrange all the necessary T&P required for the installation, testing and commissioning of electrical system

10) All the FLP light fixture are non integral type.

1.30.5 Guarantee

The goods under the scope of the supply shall be guaranteed for their compliance with IS 2148 as applicable.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
1.30.6 Certification

All the boards, light fixtures and junction boxes offered or those with similar design & construction features, manufactured by same vendor shall have been type tested by CCE Nagpur or his authorized representative or a Competent Authority like CMRS Dhanbad or equivalent.

1.31 SPECIFICATION FOR SUPPLY & LAYING OF POWER AND CONTROL CABLES

1.31.1 Scope

Under this section covers the following

1 Power Cables

2 Control Cables

1.31.2 Code and Standards:

The following standards shall be applicable amended upto date.

IS 7098 (Part I) : XLPE insulated cables for working voltages up to and including 1000 V

IS 5831 1984 : PVC insulation confirming to requirement of ST2 compound for Outer sheath of electric cables

IS 8130 1984 : Conductors for insulated electrical cables

IS 1554-1988 Specification for PVC insulated electric cables (heavy duty)Part 1 for working voltages upto and including 1100 volts(Third revision)

IS:1753-1967 : Aluminium conductors for insulated cables

IS:3961 −1967 : Recommended current ratings for cables.


IS:694 :1990 PVC insulated cables for working voltages upto and including 1100 volts (Third revision)

IS : 1255 : 1983 Code of Practice for installation and maintenance of paper insulated power cables (upto and including 33 KV)
IS : 7098(Part I) Cross linked Polyethylene(XLPE) insulated PVC sheathed Cables :Part I for working voltage upto and including 1100 Volts(Second Revisin)

1) Power Cables :
The cables shall comply the following :

a. 650/1 100V grade with stranded aluminium conductors above 6 sq.mm and stranded copper conductors upto 6 sq.mm

b. The cable shall be 2/3/3.5 or 4 Core Aluminium conductors, XLPE insulated and PVC insulated heavy duty and suitable for 1100 Volts

c. Aluminium conductor shall be standard, compacted and circular shaped and the main insulation shall be cross linked polyethylene ( XLPE ) with inner sheathing PVC extruded and each core of the cable shall have colour identification all as specified in IS.

d. Armour over the inner sheath shall be either of strip or wire type and outer sheath shall be extruded PVC Conforming to IS.

e. Cable Shall be suitable to with stand maximum conductor temperature of 90 deg C and 250 deg C during operation and short circuit respectively.

2) Control Cables
Control Cables shall be 1.1 kV grade multicore-stranded copper conductor with PVC insulation and armouring.

1.31.3 Selection of Cables

Cables should be selected considering the conditions of maximum connected load, ambient temperature, grouping factor, and allowance for voltage drops. However it is the responsibility of the contractor to recheck the lengths before cables are procured. Contractor should submit the cable length calculation to client / consultant for approval before procuring cables.

1.31.4 Insulation

1) The conductor is insulated with suitably compounded PVC applied to the conductor by the extrusion.

2) The PVC compound used for insulation shall have reduced flame propagation property. This shall also have reduced emission of hydrogen chloride gas fumes etc. when severely overheated during fires.
1.31.5 Core Identification

The cores of the cables shall be provided with the color scheme of PVC insulation as per IS for any easy identification.

1.31.6 Armouring

The armoring of multi core cable consists of either GI round steel wires or GI flat strips and in case of single core cable armoring shall be of non magnetic material such as hard drawn aluminum or aluminum alloy wires or strips.

1.31.7 Outer Sheath

The PVC compound used for outer sheath shall be resistant to termites, fungus and rodent attacks and shall also have reduced flame propagation property as specified above.

1.31.8 Identification

The manufacturer’s name, voltage grade of cable, year of manufacture, nominal cross sectional area of conductor shall be embossed on the outer sheath of the cables throughout the length of the cable at regular intervals.

1.31.9 Packing, Marking and Transport:

1. The cables shall be supplied in strong, non returnable wooden drums of heavy construction.

2. Each cable drum is marked with particulars of cable size, voltage class, length, direction of rolling, position of outer gross weight, ISI certification marking etc.

1.31.10 Storing, Laying, Jointing and Terminations:

1.31.10.1 Storing

All the cables shall be supplied in drums, on receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drum in vertical position.
1.31.10.2 Laying

Mark the routing on drawings and at site not available on drawings. Cables shall be laid as per IS 1255 : 1983. The specification given below:

1.31.11 Cables in Outdoor Trenches:

Cables shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 750mm from the Formed Ground Level (FGL) which has to be ascertained from the Consultant/Client. The width of the trenches shall not be less than 500 mm. A spacing of not less than the cable diameter shall be allowed between the cables.

The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed level. Cable unreeling from drums shall be done only with the help of cable drum rolling supports. The cables shall be laid in trenches over the rollers placed inside the trench.

The cable drum shall be rolled in the direction of the arrow for rolling. Wherever cables are bent, the minimum-bending radius shall not be less than 12 times the diameter of the cable. 15 cm thick layer of sand cushioning to be provided before laying of the cables. Cable shall be taken lifted and placed over this and cushion. The cable shall then be covered with a 15cm thick sand cushion, where cable is laid in rocky situation. Extra thick cushioning of sand as may be required/decided by the Consultant/Client shall be done without extra charge. Over this, unless otherwise specified, the cable shall be protected by bricks or tiles slabs placed on top of the trench breadth wise for the full length of the cable. Trench shall be back filled with earth and consolidated.

Cables shall be laid in RCC hume pipes at all road crossings and at the entry of hangars/shops. Approved cable markers made of concrete blocks indicating the voltage grade and the direction of run of the cables shall be installed at regular intervals of 25 mtrs. The depth of concrete blocks shall be at least 300 mm below ground and 50 mm above ground. Loops of minimum 500 mm radius at each ends should be provided.

1.31.12 Cables in Indoor Trenches

1) Cables shall be laid in indoor trenches wherever specified. Cable ladders or perforated cable trays to be used for cables laid indoors except for single cables.

2) Suitable painted MS base plate clamps, saddles, GI nuts/bolts or alternatively UV resistant tie wraps shall be used for securing the cables in position at an interval. Spacing of cable support for self supported cables on wall, ceiling or trenches shall be as follows:

<table>
<thead>
<tr>
<th>Horizontal Run</th>
<th>Vertical Run</th>
</tr>
</thead>
</table>

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
3) Plastic identification marks at every 15 m for cables laid in doors

4) All chases and passage if necessary for the laying of service cables at the entry or of premises shall have to be cut and made good to the satisfaction of the Consultant/Client

5) All cables entries into the buildings/cable trenches/ducts, etc. shall be suitably sealed as required by the Consultant/Client without extra cost.

1.31.13 Jointing and End Terminations

Cable jointing shall be done as per the recommendations of the cable manufacturer. Qualified cable jointer under strict supervision shall do jointing.

The power and control cable termination shall have the necessary brass glands and lugs as under:

- Pressure clamp insertion type up to 4 mm².
- Tinned copper and aluminium crimping lugs for higher ratings of power cables and all control cables.

Control cable termination shall be through crimping type lugs.

1.31.14 Testing

Cables shall be tested at factory as per the regulations of IS Standards. The tests shall incorporate routine tests, type tests and acceptance tests. Copy of such test certificates shall be furnished to the Consultant/Client.

Cables shall be tested at site after installation and results shall be submitted to Consultants / Client.

Power cables shall be tested after installation using 500 V insulation resistance tester and the following reading to be recorded.

- Continuity on all conductors
- Insulation resistance
  - Between Conductor
  - All conductors and ground.
1.32.1 Scope

This specification covers the supply, fabrication fixing, aligning of G.I perforated cable trays and other steel frame works at site as required.

1.31.2 Technical Details

1) The cable trays shall be designed and fabricated out of 2mm thick CRCA sheet steel etc. and got approved by Consultants/Client.

2) Before fabrication the sheet steel shall be properly cleaned to remove rust if any.

3) All materials used for fabrication of cable trays shall conform to IS 226 and fabrication shall be as per IS : 800.

4) After fabrication the cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness, and followed by galvanizing.

5) The cable trays shall be welded to the mounting supports, which in turn are either welded to plate inserts or grouted to structural members.

6) Civil contractor shall provide plate inserts for cable tray mounting supports.

7) Cable trays shall either run in cable trenches or run overhead and supported from available structure.

8) Minimum clearance between the top most tray tier and structural member shall be 300 mm.

9) The type and size of tray to be used shall be as required.

10) Each continuous length of cable tray shall be earthed at minimum two places.

11) All hardware such as passivated bolts, nuts; washers, and other consumable required for the fabrication and erection shall be included in the rate quoted by contractor. However, if any grip/anchor bolts or fasteners are required, the same may be brought without extra charge.

12) The cable trays, accessories, covers etc. shall be galvanized. Where any cuts or holes
are made or welding is done on finished steel work, the same shall be sealed against oxidation by red oxide primer followed by finished paint.

1.32 SPECIFICATIONS FOR DISTRIBUTION SYSTEM, CONDUITS, WIRING & ACCESSORIES

1.32.1 Scope

The scope under this section covers conduit wiring for the following:

- Lighting circuits
- Power circuits - Equipment and Machinery, wherever applicable
- Telephones & LAN circuits wherever applicable

1.32.2 Standards

IS:732-1989 Code of practice for electrical wiring installation
IS:1646-1961 Code of practice for fire safety of buildings(General) electrical Installations(Second revision)
IS:1554 (Part I) 1988 PVC insulated cables Part I : for working voltages upto and including 1100 volts(Third revision)
IS:1087 : 5 A tumbler switches
IS:2120 15 A tumbler switches
IS:1293 : 2005 3 pin plugs and sockets
IS : 3854 : 1966 Switches

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

IS 694: 1990 Specification for PVC insulated sheathed or unsheathed cables for working voltages up to 1100 volts

IS : 1596-1977 Specification for Single core cable, polyethylene insulated cables for working voltage upto and including 1100 volts
1.32.3 Rigid Heavy Duty MS Conduits & Accessories

1.32.3.1 All conduit and conduit fitting and accessories shall be of rigid metallic conduit as indicated and shall comply with following Indian Standards.


IS 2667 : 1988 Specification for fittings for rigid steel conduit for electrical wiring. The conduit fittings shall be made off steel, cast iron or malleable cast iron, malleable iron casting shall be well annealed.

IS 3480 : 1966 Specification for flexible steel conduit for electrical wiring

IS 4649 : Specification for adaptors for flexible steel conduit

IS 3419 : 1988 Specification for fittings for rigid Non metallic conduit

IS 9537 Part -2 : 1981 Rigid steel Conduit

IS 9537 Part -3 : 1983 Plain rigid conduit of insulating material

1.32.3.2 Requirement

MS conduits shall be of welded and screwed sheet steel construction. Conduits shall be black stove enameled inside and outside. The conduits shall conform to the requirements of relevant IS (latest edition) in all respects. The conduits shall have uniform wall thickness/cross section throughout.

Conduits shall bear the name, trademark of the manufacturer and size of conduit on each length. The conduits shall be delivered to the site in original bundles. Conduits of less than 19 mm dia. shall not be used. The minimum wall thickness of conduits shall be as follows:

Rigid MS Heavy Duty Conduits

a) 19, 25 & 32 mm - 16 SWG

b) 38 mm & above - 14 SWG

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

1.32.3.3 Conduit Accessories

1) Conduit accessories such as bends, inspection bends, inspection tees, elbows, reducers, draw boxes, junction boxes, etc. shall be of approved makes. Boxes shall have internally
2) All conduits shall be of ample size for easy 'draw in' and 'draw out' of all the wires in the conduits. In no case the total cross section of wires measured over all be more than forty percent of the area of the conduit.

3) All the conduits shall be adequately protected while stored on site prior to erection and no damaged conduit shall be used.

1.32.3.4 Preparation of conduit:

The inside surface and ends of conduits and threads and fittings used shall be clean, smooth, cut square and free from burrs and other defects. Powdered soapstone, talc or prepared compounds shall be used as lubricants to facilitate the smooth pulling in of conductors.

1.32.3.5 Erection of Conduit

1) The conduit shall be properly and tightly screwed between the various lengths and to the boxes to which it runs and terminates. No part of the conduit shall be under mechanical stress and the whole conduit system shall be electrically and mechanically continuous throughout.

2) Conduits shall be installed with provision for ventilation self drainage in the event of ingress of moisture due to condensation or any other reason and prevent sweating.

3) A suitable drainage hole shall be drilled in the bottom of the lowest conduit box at equal length of horizontal length.

1.32.3.6 Installation of Surface Conduit System

1) Conduits shall run in square and symmetrical lines. Before the conduits are installed, the exact routes shall be marked at site and approval of the Architect shall be obtained. Heavy gauge GI base plates, saddles, secured to suitable crawl plugs, at an interval of not more than 1 meter, shall fix conduits. Conduits shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers or running type couplers or pull boxes shall be provided.

2) Bends of conduit runs shall be done by pipe bending machine. Bends, which cannot be negotiated by pipe bends, shall be accompanied by introducing inspection boxes or inspection bends. Not more than three equivalent 90° bends shall be used in a conduit run from outlet to outlet.
3) All the conduit openings shall be properly plugged with PVC stoppers/bushes. The conduits shall be adequately protected against rust by applying two coats of approved synthetic enamel paint after the installation is completed.

4) Wherever conduits terminate, conduits shall be rigidly connected to the box/board with brass hexagonal check nuts with compression washers on either side of the entry to ensure proper electrical and mechanical continuity.

5) The crossing of surface conduits shall not be generally permitted and to avoid such crossings, adopter boxes shall be used at junctions/crossings.

6) All unused conduit entries shall be blanked off in an approved and where conduits terminate in adopter boxes. All removable box covers shall be firmly secured to provide complete enclosure.

1.32.3.7 Conduits Above False Ceiling

1 In the false ceiling area, the conduits shall be run above the false ceiling frame work supported by means of M.S straps secured and fixed to both conduits and structural ceiling, keeping the outlet box as near as possible to the fittings/fans for connections.

2 The conduit boxes for fittings/fans are independently supported by means of separate fixing arrangements to the box and structural ceiling so that the box is held rigidly.

1.32.3.8 Laying of Conduits

The size of conduit shall be selected on the following basis:

<table>
<thead>
<tr>
<th>Wire (mm²)</th>
<th>20</th>
<th>25</th>
<th>32</th>
<th>40</th>
<th>50</th>
<th>63</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>x</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>1.5</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>x</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>2.5</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6</td>
<td>x</td>
<td>2</td>
<td>4</td>
<td>x</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>10</td>
<td>x</td>
<td>x</td>
<td>2</td>
<td>4</td>
<td>X</td>
<td>x</td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL

<table>
<thead>
<tr>
<th>EMPLOYER</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>50</td>
</tr>
</tbody>
</table>
The conduit laying shall be as follows:

1) As per the routes indicated on the drawing or to be marked on the drawing and at site and got approved before laying.

2) Supported on saddles spaced at 500 mm. and run parallel or at right angle without crossing over or concealed as directed.

3) Conduit junction boxes/pull through boxes to be installed at spaces not than 12 m or two 90 deg C. The junction boxes shall be finish with or wall in case of concealed conduits.

4) Conduits to be kept at 100 mm minimum from pipes and non-electrical services.

5) Separate and colour coded conduits/runways to be used for:
   - Lighting circuits
   - Emergency lighting circuit
   - Power circuit
   - Low voltage circuits

6) Fixing screws to be rust proof round or cheese head screws.

7) Conduit buried in concrete to be fastened to the reinforcement approved before casting the slab.

8) Conduits embedded in wall to be fixed by staples at 500 mm intervals.

9) Conduits embedded in floor screed to be galvanised and painted emulsified bitumen.

10) Conduits to be rendered continuous before pulling the wires.

11) Conduits to be free from sharp edges and burns and necessary bushings to be provided at each junction box and out boxes.

12) Outlet boxes to have minimum size of 50 x 50 x 32 mm.

13) Flexible conduits are acceptable only at machine end and for extension to (outlets) (not exceeding 500 mm.) in false ceiling.
1.32.4  Enclosure for Electrical Accessories

1)   Enclosure for electrical accessories shall conform to IS: 5133 Part I. The wall thickness of MS enclosures shall be not less than 1.6 mm. The enclosure boxes shall be provided with a minimum of four fixing lugs located at the corners for fixing the covers. All fixing lugs shall have tapped holes to take machined brass screws.

2)   Sufficient number of knockouts shall be provided for conduit entries. The enclosures shall be adequately protected against rust of corrosion both inside and outside. The enclosures shall be provided with 5 mm thick overlapped white PVC or perspex sheet cover with rounded corners and beveled edges for mounting switches, sockets etc. Wherever different phase conductors are brought into the same enclosure, phase barriers shall be provided.

3)   Minimum size of the box shall be 75 x 75 x 75 mm.

4)   Draw boxes of ample dimension shall be provided at convenient points on walls/ceilings to facilitate pulling of long runs of wire. These boxes will be as few as possible and located where found necessary and approved by Architects at no extra cost.

5)   Where flush conduits are required to terminate at surface mounted equipment, the conduit shall terminate at a flush box and the back of the equipment should fully cover the flush box and brass screws shall be used between the equipment and the box in addition to any other means of fixing and earthing arrangement.

The alternative arrangement to the above shall be by means of fixing a terminal extension box to the flush conduit box in which case a break joint ring shall be fitted between boxes.

1.32.5  Wiring Conductors

All wiring conductors shall be PVC insulated, copper conductors of 1100 V grade for single phase and three phase circuit and shall conform to IS: 694 Part II (Latest Edition).

   Colour coded as follows :

   Phase-R - Red
   Phase-Y - Yellow
   Phase-B - Blue

   Neutral - Black
   Earth - Bare or Green if insulated.

   The wires shall be supplied in sealed coils of 100 mtr. length and shall have manufacturer's
1.32.5.1 Installation of Wiring Conductors/Cables

1) The wiring conductors shall not be drawn into the conduits until all the works of any nature that may cause damage to the wires are completed. The installation and termination of wires shall be carried out with due regard to the followings:

i. While drawing the wiring conductors, care shall be taken to avoid scratches and kinks, which cause breakage of conductors. There shall be no sharp bends in the conduit system.

ii. Strands of the wires shall not be cut for connecting to the terminals or lugs. The terminals shall have adequate cross section to take all the strands.

iii. Oxide inhibition grease shall be applied at all terminals and connections.

iv. Brass flat washers of large area shall be used for bolted terminals.

v. Bi-metallic connectors should be used wherever aluminum conductors are tapped from copper mains or vice versa.

2) Wiring for power and lighting circuits shall be carried out in separate and distinct wiring systems.

3) The wiring system envisaged is generally shown on the layout drawings and line diagrams. However, a brief account of the general wiring system is given below:

i. Sub mains wiring wiring from Meter boards/switch boards to the individual distribution boards, and shall consist of wires, conduits, and all conduit and fixing accessories as required and specified. The sizes of conduits and number of wires shall be as specified in Schedule of Quantities. Wires shall be drawn in conduits as required without being damaged, with necessary draw boxes if required. The wire lengths must be adequate for terminating at either end and identifying ferrules shall be provided at termination. The wiring shall be color coded. The rate shall include all materials, connections, labor etc. as specified above.

ii. Circuit wiring Wiring from DB’s to the first point control boxes for lighting, fans, 5A sockets call bells etc. The scope of work shall be same as in sub main wiring.

iii. Power wiring - The wiring from DB’s to heating supplies, 15 A 3 pin socket outlets, etc. The scope of work shall be same as in sub main wiring.
iv. Each sub main/circuit main/power wiring circuit shall also have its own earth continuity wire as specified.

v. All the wiring shall be carried out in loop in loop system only and phase or line conductors shall be looped at switch box and neutral conductor can be looped from light, fan or sockets.

vi. The maximum number of various size conductors that could be drawn into various sizes of conduits shall be as per table II of IS:732 (Latest Edition). The wiring shall be color coded for easy identification of phases and neutral. The following color codes shall be adopted:

- Phase's: Red, Yellow and Blue
- Neutral: Black
- Earth: Green or Bare wire as specified

vii. All sub mains and circuit wiring shall be provided with printed PVC identification ferrules at either end bearing the circuit number and designation.

viii. Control switches to be connected to phase conductor only.

ix. All connections to switches, sockets etc through crimped barrel ferrules and lugs.

x. 2 way controls for all passage/staircase/corridor lights etc

1.33 SWITCHES, SOCKETS AND ACCESSORIES

1.33.1 Standard

Sockets outlets, surface or flush type, 5A or 15 Amp, 250 Volts shall three pin shuttered / non shuttered or interlocking type as indicated and shall comply with the following Indian standards:


IS 4615 - 1968: Switch sockets outlets (non interlocking type)
1.33.2 General Requirements

1. General control switches shall be of a 5A rating and shall be of approved make/type suitable for flush mounting.

2. All sockets, 5A and 15A ratings shall be of flush mounting type with combined control switches of the same rating as that of the sockets. All sockets outlet shall be of 3-pin type.

3. The switch, plug socket or regulator boxes shall be made of GI/sheet steel of minimum 16 SWG on all sides except in the front. Depth of boxes shall not be less than 75 mm and suitably increased where fan regulators are mounted in flush pattern. The boxes shall be provided with suitable earthing studs. Wherever required switches/fittings shall be fixed on metal strip, which in turn are welded to the box.

4. Fan regulators shall be flush type and earthed with earth continuity conductor. The fan regulator shall be of electronic type.

1.34 LAMPHOLDERS, CEILING ROSES, ETC.

1.34.1 General Requirement

1. Accessories for light outlets such as lamp holders, ceiling roses, etc. shall be in conformity with requirements of relevant specification. Only approved make of accessories shall be supplied.

2. Screwed holder shall be used in brackets and pendants, light fittings shall have brass holders on T.W. round blocks.

3. Ceiling roses for recessed system of wiring shall be porcelain make and flush type.

4. For surface type of wiring this shall be bakelite.

Above all follow the Indian Standards
1.34.2 Installation of Switches, Sockets and Accessories

All the switches shall be wired on phases. Connections shall be made only after testing the wires for continuity, cross, phase etc. with the help of megger.

Regulators shall be fixed on adjustable MS flat straps inside the enclosure. The arrangement of switches and sockets shall be neat and systematic. Covers for enclosures accommodating switches, sockets etc. (point control boxes) shall be of modular type and fixed to the enclosure in plumb with counter sunk head. Outlets shall be terminated into a flush type fan box for fan points. For wall plug sockets, the conductors may be terminated directly into the switches and sockets.

The outlets point control boxes etc. shall be set out as shown on the drawings. Before fixing these, the contractors shall obtain clearance from the Consultant/Client with regard to their proper locations. The enclosures of sockets/third pin of the sockets shall be connected to the ground through an earth continuity wires, as specified.

1.34.3 Capacity of Circuits

Light points, 5A socket points, fans, and call bell points may be wired on a common circuit. Such of those circuits shall not have more than 4 nos. of light/socket points or a load of 800 W whichever is less. Not more than two numbers of 15A socket outlets shall be wired on the same circuit.

1.34.4 Point Wiring

1) Point wiring shall commence from the first point control box/local control box for the points connected to the same circuit. Point wiring for lights, ceiling and exhaust fans, 5A sockets, call bells etc. shall be carried out with 1100 V Grade PVC insulated wires.

The point wiring shall be inclusive of conduits of not less than 19 mm size, switches, wiring along with conduit accessories such as bends, inspections bends, reducers, pull boxes, junction boxes, switch boxes, fan boxes, covers etc. together with wiring accessories such as ceiling roses, brass lamp holders, T.W Blocks, loose wires up to 1 mtr. long at outlet end connectors point control boxes (enclosure for electrical accessories) switches, etc.
Point wiring shall be provided with earth continuity wire as specified for earthing third pin of sockets, luminaries and fan fixtures. Light control shall be either single, twin or multiple points controlled by a switch, as specified.

2) The point wiring for Light/Fans/5A sockets etc shall include the supply and installation of all materials specified above. Any item not specifically included but required for satisfactory completion of the point wiring shall also be included. No separate extra price will be allowed for any item under point wiring.

3) A dependent socket point shall mean the combination 5A switch socket outlet/point mounted on the same switchboard as any other point/points and shall include the 5A switch and socket.

4) The fan point shall be complete with fan hook box flush mounted in slab, control switch mounted in switch box and electronic regulator, complete with cover. The measurement will be numbers of each kind of point and as specified in Schedule of Quantities.

5) Maximum 2 circuits(of same phase) per circuit

6) No joints of cables, only looping from point to point.

7) Control switches should be connected to phase only.

8) All connections to switches, sockets etc through crimped barrel ferrules and lugs.

1.34.5 Light Fittings

Unless otherwise specified, light fittings shall be generally fixed as directed by Consultant/Client.

1) Fittings such as wall brackets shall be fixed at 2200 mm from FFL.

2) All CFL Luminaries shall be fixed on false ceiling as shown in drawings.

3) The fluorescent fittings shall be fixed in such a manner that the wiring conductors shall not terminate in a ceiling rose but in a junction box 300 mm away from the center of the fitting along the length of the fitting so that no exposed wiring is seen from outside.

4) One sample installation to be get approved by Consultant/Client
1.34.6 Ceiling Fans

1) Ceiling fans shall be suspended from the special fan hook boxes. The fan wiring shall be terminated in porcelain/PVC multi way connector.

2) Each fan shall have a separate switch and speed regulator. The canopy at the top of the suspension rod shall effectively hide the suspension hook.

3) The control switch and the electronic regulator for the fan shall be included in the point wiring.

1.34.7 Earthing

1) Bare 16 SWG copper earth conductors shall be run along with the exposed / surface laid conduits and clamped at ever,’ m. intervals and at both ends using earth clamps.

2) The number of earth wires to be provided are as follows:
   - Single conduit : 1 No
   - 2 to 4 conduits : 2 No
   - 5 to 8 conduits : 3 No
   - 9 to 12 conduits : 4 No

3) In case of concealed wiring, copper conductor green PVC insulated wire shall run in the conduit.

4) All outlet boxes, switch and socket boxes, sockets properly.

1.34.8 Testing of Electrical Installation

1) Testing of Insulation Resistance
2) Testing of earth continuity path
3) Testing of polarity of non linked single pole switches

Test Certificate shall be submitted for all tests to the Consultant/Client.

1.35 SPECIFICATION FOR LIGHT FITTINGS AND ACCESSORIES

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

1.35.1 Scope
The scope under this section covers the following selection, testing at works, inspection and delivery at site of following light fittings and their associated accessories.

1.35.2 Standards

The light fittings and their associated accessories such as lamps/tubes, reflector, housings, ballasts etc. shall comply with the latest applicable standards and codes.

Where no standards are available, the supply items shall be backed by test results, shall be good quality and workmanship & any supply items which are brought out by the Contractor shall be procured from the approved manufacturers acceptable to the Employer.

1.35.3 General Requirements

i. Fittings shall be designed for continuous trouble free operation under atmospheric conditions as specified without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather-proof and rain-proof type.

ii. The fittings shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps / starters etc.

iii. Connections between different components shall be made in such a way that they will not work loose by small vibration.

iv. For each type of lighting fitting the Contractor shall supply the utilization factor to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.

v. All fittings shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage.

vi. The fittings and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant standards.

vii. All mercury vapor, metal halide lamp and sodium vapor lamp fittings shall be complete with accessories like lamps, ballasts, power factor improvement capacitors, starters wherever applicable, etc. These shall be mounted as far as possible in the fitting assembly only. If these cannot be accommodated inside, then a separate metal enclosed box shall be included to accommodate the accessories and in addition with a fuse and a terminal block suitable for loop-in, loop-out connections. Outdoor type fittings shall be provided with outdoor type weather proof box.

viii. All fluorescent lamp fillings shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters and capacitors for correction of stroboscopic effect.
Each fitting shall have a terminal block suitable for loop-in, loop-out and T4 connection by 250/440V, 1 core, PVC insulated Cu conductor cable upto 4 sq mm, in size unless otherwise specified. In hazardous areas, the termination at the fittings shall be suitable for 1100 V, PVC, armoured cables of sizes specified and terminals shall be of stud or clamp type. The internal wiring should be completed by the MANUFACTURER by means of stranded copper wire and terminated on the terminal block.

The mounting facility and conduit knock-outs for the fixtures shall be as specified.

Al) hardware used in the luminaries shall be suitably plated or anodized and passivated for use in chemical industrial and power plants.

1.35.4 Earthing

1) Each light fitting shall be provided with an earthing terminal suitable for connection to the earthing conductor.

2) All metal or metal-enclosed parts of the housing shall be bonded to the earthing terminal so as to ensure satisfactory earth continuity throughout the fixture.

1.34.5 Painting/Finish

1) All surfaces of the fittings shall be thoroughly cleaned and de-greased. The fittings shall be free from scale, sharp edges and burns.

2) The housing shall be stove-enamed/epoxy stove-enamed/vitreous enameded powder-coated of anodized as indicated under various types of fitting.

3) The finish of the fitting shall be such that no bright spots are produced either by direct light source or by reflection.

1.35.6 LIGHT FITTINGS:

A) Decorative Type Fittings

Decorative fluorescent fittings shall be provided with mounting /housing channel cum reflectors of CRCA sheet steel, stove enameded.

Diffusers, mirror or louvers shall be provided as required. Diffusers shall be of translucent white opal acrylic or polystrene. Louvers shall be square polystrene or moulded plastic. Mirror shall be fine polished aluminium.
Fittings shall be suitable for the number of lamps of specified wattage, for directly mounting on ceiling/ conduit suspended or for recess mounting in false ceiling, as specified.

Decorative incandescent fittings when required, shall be suitable for 60/100/150W lamp, suspended or recess mounting in false ceiling. The fitting for recess mounting shall be provided with copper anodized finished cylinder, ceiling mounting ring and translucent acrylic crystal ring.

B) Industrial Type Fittings

These fittings shall be suitable for use with incandescent/ fluorescent / mercury vapor / sodium / Metal halide lamps as per requirements and generally as described below.

The angle or cut-off for fittings with filament lamp shall not exceed 70° C and that for fittings with fluorescent tubes shall not exceed °.

The luminous output of each reflector shall not be less than:

a. 60 % in case of vitreous enameled reflectors with incandescent and mercury vapour lamps.

b. 80 % in case of anodized aluminium reflectors with lamps as in (a) above

c. 75 % in case of fluorescent lamps irrespective of the type of reflector used

The distribution of light shall be such that at least 80% of the total luminous flux from the fitting shall be in the lower hemi-sphere.

Fluorescent lamps to be mounted in the false ceiling shall be installed so as to form a continuous luminous ceiling, shall have an inside reflector of non fluorescent power occupying 2/3 of inner surface of the tube so that the lamp radiates light mainly in the direction determined by the position of the reflective material.

C) Fluorescent Lamp / CFL Fittings

For general industrial use in humid atmosphere, the fittings shall be provided with CRCA sheet steel mounting / housing channel vitreous enameled and with vitreous enameled reflector of minimum 20 SWG thicknesses.

For dusty and vapour prevalent atmosphere, the fittings shall be dust and drip proof type, totally enclosed in sheet steel housing with a heat resistant toughened gla cover or clear acrylic sheet. The housing shall be epoxy stove-enameled neoprene gaskets shall be provided for sealing.
For atmosphere where chemical vapours fumes are corrosive, the material fitting housing mounting, reflectors and end-plates shall be of cast aluminium, aluminium sheet and finished in epoxy stove enamel to resist corrosion. Control gear housings, starters and tube holder assemblies shall be provided with neoprene gaskets to make it proof against entry of corrosive vapours.

Fittings shall be suitable for the number of lamps of specified wattage, for dire mounting on ceiling / wall and or conduit suspended.

D) Incandescent / Mercury Vapour Lamp Fittings

E) Bulkhead and Well glass Type

i Bulkhead, weather-proof type fittings for use in corridors, staircase landings covered porches and low ceiling factories, shall be suitable for direct fixing to wall ceiling and to accommodate upto 150 watts incandescent lamp. The fitting shall be provided with housing of cast aluminium alloy with stove enamelled finish, prismatic heat resistant glass cover hinged on to the housing and fixed by screws, Neoprene gaskets shall be provided to make the fitting weather-proof. For mechanic protection to glass cover, a protective wire-guard of 3 mm galvanized wire with stove enamelled finish paint shall be provided.

ii Well glass, weather-proof type fittings for use in building exteriors and common walls, shall be suitable for conduit mounting and to accommodate upto 200 wail incandescent lamps or 125 W HPMV lamp. The fitting shall be provided with stove enamelled cast aluminium housing with top conduit entry, heat resistant clear glass cover unit hinged to the housing and fixed by screws. The fittings shall be provided with neoprene gaskets and wire guards as started in above item.

F) High Bay / Low Bay Type

The fittings shall be suitable for mounting to the roof structure and for this purpose suitable hook for suspension shall be provided. The fitting shall be suitable for up 400 watts mercury vapour/metal halide lamp. If mercury vapour lamp or metal halide is provided, the fitting shall be provided with an integral housing for the control gear complete with ballast, capacitor, fuse-gear and internal wing.

The integral housing shall be designed for efficient cooling of the unit. The canopy and housing shall be of cast aluminium, stove-enamedled and the reflector shall anodized aluminium sheet, mirror polished.

G) Post-Top Lantern Type

Post-top mounting fittings for illumination of walkways, gardens, entrances of buildings.
H) Street Lighting Fittings

i. Street lighting fittings shall be suitable for metal halide, mercury vapour lamps, fluorescent tubes or sodium vapour lamps and shall be of the cut off, semi-cut off or non-cut off type as specified.

ii. The fittings shall be of the tope entry / side entry / post top / suspension type as specified.

iii. The means for attaching the fittings shall be designed to sit the weight of the fitting and shall ensure that the strength of the connection is adequate to withstand a wind speed of 150 Km/h equivalent to the following wind loads on the projected surface of the fitting in relation to its mounting height:

<table>
<thead>
<tr>
<th>Mounting Height</th>
<th>Wind Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 8m</td>
<td>- 15 N/m²</td>
</tr>
<tr>
<td>8 to 16 m</td>
<td>- 20 N/m²</td>
</tr>
<tr>
<td>Above 16 m</td>
<td>- 24 N/m²</td>
</tr>
</tbody>
</table>

iv. The size of threads, length of threads, socket bores of various types of fittings mentioned in 8.2 above shall comply with relevant standards specified.

v. The fittings shall be designed such that the glare value is controlled below an acceptable level. The light distribution patterns of cut-off, semi-cut off and non-cutoff fittings shall be as per relevant standards specified.

vi. The required control gear such as ballast and capacitor shall be provided integral with the fitting. The housing shall be of cast aluminium stove-enameled and provide with anodized, mirror or polished aluminium reflectors. The covers shall be of transparent acrylic sheet and neoprene gasket shall be provided for sealing the unit for outside atmosphere.

I) Instalite Type Emergency I Exit Fitting

i. Instalite type lighting fittings for providing emergency light during failure of normal AC supply shall be suitable for the incandescent/fluorescent lamp of wattage as specified.

ii. The fittings shall be suitable for connection on I phase, 230V, 50 Hz supply. On failure of AC supply the fitting shall pick-up automatically and on restoration of AC supply, the
The fitting shall be complete with 18/21/36W incandescent or fluorescent lamps, metallised mirror reflector, dry leak-proof battery, battery charger, push-button control, test switches, indicating light for battery on charge and any other accessories required for satisfactory operation of the fitting.

1.35.7 ACCESSORIES FOR LIGHT FITTINGS:

Fluorescent tube lamps, fitting and accessories shall comply with following standard.

IS 1596 :1976 Capacitor for use in tubular fluorescent, high pressure mercury and low pressure sodium vapour discharge lamp circuit.

IS 1777 :1978 Industrial luminaries with metal reflectors

IS 2215 :1983 Starters for fluorescent lamps

IS 2418 (Part 1 to 4) Tubular fluorescent lamps for general lighting services :1977

IS 3323 :1980 Bi-Pin lamps holders for tubular fluorescent lamps

IS 3324 :1982 Holders for starters for tubular fluorescent lamps

IS 3287 :1965 Industrial light fittings with Plastic reflector

1.35.7.1 Reflectors

1) The reflectors shall be made of CRCA sheet steel/ aluminum / silvered glass/chromium plated sheet copper as indicated for the above-mentioned fittings unless otherwise specified.

2) The thickness of steel / aluminum, shall comply with relevant Standards specified. Reflectors made of steel, shall have stove-enameded/Vitreous-enameded/Epoxy-coating finish. Aluminum used for reflectors, shall be anodized / epoxy stove-enameded/mirror polished. The finish for the reflector shall be indicated above mentioned fitting.

3) Aluminium paint on the reflectors of flameproof fittings is prohibited.

4) Reflectors shall be free from scratches or blisters and shall have a smooth and glossy
5) Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

1.35.7.2 Lamp/ Starter Holders

1) Lamp Holders shall comply with relevant Standards. They shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met within normal installation and use.

2) Lamp Holder for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pings when in working position.

3) Starter holders for fluorescent lamps shall conform to the relevant Standards. All material used in the construction of the holder shall be suitable for tropical use.

4) The Starter Holder shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

1.35.7.3 Ballasts

1) The ballasts shall be designed, manufactured and supplied in accordance with the relevant Standards. The ballasts shall be designed to have a long service life and low power loss.

2) The electronic ballasts shall be fully enclosed in an aluminum housing shall include a divided wiring compartment to separate the power leads from the control leads. All leads to be color coded.

3) The electronic ballast shall be multi voltage capable and operate from a voltage range of 180–305V at 50Hz.

4) Ballasts shall be mounted using self locking, anti-vibration fixings and shall to remove without demounting the fittings. They shall be in dusting combustible enclosures.

5) The ballasts shall be of the inductive, heavy-duty type, filled with then insulating...
moisture repellent polyester compound filled under pressure or Ballasts shall be provided with tapings to set the voltage within specified. End connections and taps shall be brought out in a suitable block, rigidly fixed to the ballast enclosure. The ballast wiring shall be rigid wire. They shall be free from hum. Ballasts which produce humming be replaced free of cost by the VENDOR.

6) Separate ballast for each lamp shall be provided in case of multi lamp fittings.

1.35.7.4 Lamps

1) The fluorescent lamps shall be "Cool Day Light" type unless otherwise specified and shall be provided with features to avoid blackening of lamp ends. The fluorescent lamps shall have a high lumen output of 3250 lumens. The lamp shall have triple coil electrode with an anode ring and a tri-band Phosphor coating.

2) The lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments/electrodes, shall not break under such circumstances.

3) Lamps/Tubes shall conform to relevant Standards and shall be suitable for supply voltage and frequency specified.

1.35.7.5 Starter

1) Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference capacitor.

2) The starters shall generally conform to the relevant Standards.

1.35.7.6 Capacitors

i The capacitors shall have a constant value of capacitance and shall be connected. across the supply of individual lamp circuits

ii The capacitors shall be suitable for operation at supply voltage and shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.95 lag or better.

iii The capacitors shall be hermetically seated preferably in a metal enclosure to prevent seepage of impregnant and ingress of moisture.

1.35.7.7 Spare Parts
i. Unit prices of the items shall be quoted together with catalogue numbers.

ii. The unit prices shall not however be limited to the above items. The VENDOR may recommend additional spare items and quote the unit prices of the respective items.

1.35.7.8 Tests and Test Reports

i. Type tests, acceptance tests and routine tests for the lighting fittings and covered by this specification shall be carried out as per the relevant standards for the respective fittings and their accessories.

i. The MANUFACTURER’s type and routine test certificates shall be submitted for tests conducted as per relevant standards for the fittings and accessories. The BIDDER shall submit with his proposal copies of available test certificates of the fittings offered.

1.36 SPECIFICATION FOR EARTHING SYSTEM

1.36.1 Scope

The scope under this section covers the following:-

a) Providing Earthing Station.

b) Providing Main Earth Grid

c) Earthing of all panels, DB’s and utilisation equipments.

1.36.2 Codes and Standards

1. The Earthing systems shall comply with all currently applicable standards, regulations and safety codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

2. The installation work shall conform to the latest applicable Electricity Rules, Relevant Indian Standards and Codes of Practices as follows:

IS : 3043 -1987 Code of Practice for Earthing (First revision)

IS : 732 -1989 Electrical Wiring Installations
1.36.3 Earthing Electrodes

1) Earthing electrodes shall be designed as per the requirements of IS 3043. The resistance of earth electrodes shall be as low as possible, the maximum allowable value being one Ohm.

2) Earth electrodes shall be as far as possible embedded below permanent moisture level. Earth pits shall be further treated with salt and charcoal to improve the soil resistivity. In rocky areas where the required earth resistance cannot be attained using the standard earth electrode. Configuration then application of deep well earth pits should be examined.

1.36.4 Plate Electrode (Copper Plate)

Plate electrodes shall be made of copper plate of 3.15 mm thick and 600 x 600 mm size. The plate shall be buried vertically in ground at a depth of not less than 2.5 mtrs to the top of the plate, the plate being encased in powdered charcoal to a thickness of 15 cm all-round. Salt and river sand shall not be used.

Earth leads to the electrode shall be laid in a medium grade GI pipe and connected to the plate electrode with brass bolts, nuts and washers. The GI pipe of 19 mm dia. shall be placed vertically over the plate and terminated in a funnel of 5 cm above the ground.

The funnel shall be enclosed in masonry precast chamber. The chamber shall be provided with CI frame and CI cover. The earth station shall also be provided with a suitable permanent identification label/tag.

1.36.5 Safe Earthing Electrode (S.E.E)

Safe Earthing Electrode Type-19 shall comprise of a GI pipe with outer dia. of 50 mm and inner dia. of 25 mm. The electrode is manufactured from GI pipe with adequate galvanization (i.e., more than 80 – 100 µ) to ensure maximum conductivity. The electrode shall not be less than 3.0 Mtrs long buried vertically in a pit of 450 x 450 mm size and filled with back fill compound and connected at the top to a medium grade GI pipe of 19 mm dia, clamped to the pipe electrode with brass bolts, nuts and washers.

The top end of the pipe shall be threaded and provided with G.I cap. A hole shall be provided at 100 mm from the top end to receive a 13 mm bolt with double nuts and washers. The funnel
and the earth lead connections shall be enclosed in a masonry precast chamber/inspection pit. The chamber shall be provided with C.I frame and C.I cover. A proper permanent identification tag/label/earth cable marker shall be provided for each electrode.

1.36.6 General Requirements:

1) Each installation shall have one common earth grid connected to at least two groups of earth electrodes.

2) The earth grid shall extend throughout the installation in the form of a ring circuit with branch connections to the equipment and structures to be earthed.

1.36.7 Earthing Cables and Connections:

1) Earth systems shall be of solid copper/galvanized flats type, of cross-section specified on the relevant design earth layout drawing.

2) Connections between earth electrodes and main ring earth conductors shall be executed in accordance with Electrical Drawings and in such a way as to facilitate the inspection and testing the earth resistance of each individual earth electrode group without disconnection of the earth system main ring.

3) All un insulated parts of earth conductors shall be suitably protected against direct contact with the soil to prevent electrolytic corrosion. This may be achieved by lap wrapping bared sections with green PVC adhesive tape.

4) All Earthing terminations shall be made with compression type cable lugs. Interconnections shall be directly clamped with compression type branch connectors as detailed in Electrical Drawings.

5) Execution of earth cable branch connection by means of exothermic welding shall require the approval of The Company Site Representative, who will take into account the suitability of the welding equipment and the previous experience of the Contractor’s personnel.

6) The resistance between each earth electrode configuration and the general mass of earth shall not exceed 5 ohms when isolated from the main earth grid.

7) Location of earth electrodes, earth conductor’s connections and earth cable routes shown on the installation earth layout drawing shall be considered as diagrammatic only, and site inspection shall be necessary to determine earth connection onto equipment’s locations and conductor routes prior to installation.

8) Within buildings, strips of high conductivity copper/GI, sized in accordance with the layout
9) Where copper tape or cable is fixed to building structure it shall be by means of purpose made saddles.

11) Fixings shall be made using purpose made lugs and clamps.

12) Fixings requiring drilling of holes through stripes shall be used, considering the effective cross-section of the particular run is within relevant regulations.

13) Where tape or cable is run in the ground or fixed externally, and is liable to corrosion, it shall be wrapped with corrosion-resistant material. Alternatively, PVC wrapped tape or cable may be used.

14) Joints in copper tape shall be tinned before assembly, riveted with a minimum of two rivets, and sweated solid.

15) Where holes are drilled in the earth tape for connection to items of equipment, effective cross-sectional area of connections shall be not less than required to comply with the relevant Regulations.

16) Bolts, nuts and washers for any fixings of earth tape shall be of high-tensile grade.

1.36.8 Electrical Equipment

1) Metallic enclosures of all electrical equipment shall be earthed at two ends by connection to the common earth grid.

2) Cross-sectional area of the equipment earth connections shall be in accordance with the earth layout design drawing.

1.36.9 Non-Electrical Equipment

SIGNATURE OF TENDERER WITH SEAL

1) All metallic equipment used for storage, processing, transportation or pumping flammable liquids, vapors or gases, and their associated supporting structure or skid, shall be electrically bonded to the installation main earth ring.

2) Electrical bonding of associated metal work, in handrails, walkways, etc., is not necessary if it is demonstrated by testing that they are electrically continuous with the structure. However, the same shall be bonded to earth at one point.

3) Piping which is not in electrical contact with its associated tank or vessel, such as an
4) In installations that do not contain electrical equipment, the resistance between each earth electrode configuration and the general mass of earth shall not exceed 5 ohms when isolated from the main earth grid.

1.36.10 Bonding

1) Metal sheaths and armoured of all cables operating at low voltage, metal conduits, ducting, trucking, and protective conductors associated with such cables, which might otherwise come into contact with adjacent fixed metalwork, shall be effectively either segregated from, or bonded to, adjacent metal work.

2) Metallic sheaths and / or non-magnetic armour of all single-core cables in the same circuit normally shall be bonded together at one and end only have there run (solid bonding) unless specified otherwise.

3) All interior metal, water and gas piping shall be bonded together and made electrically continuous. Non-conductive coatings (such as paint, lacquer and enamel) on equipment to be earthed shall be removed from threads and other contact surfaces to ensure good electrical continuity.

1.36.11 Testing

The following earth resistance values shall be measured with an approved earth meggar and recorded:

1. Each Earthing Station
2. Earthing System as a whole (shall be less than one ohm)
3. Earth Continuity conductors.

1.38 SPECIFICATIONS FOR STREET LIGHT POLES AND POSTS

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

1.38.1 Scope
This specifications covers the design, material specification, manufacture, testing, inspection, delivery to site and installation & commissioning of Street Light Poles, light fitting and its associated accessories.

1.38.2 Street Light Poles :

1) The street light poles/pathway light poles shall be of swaged type construction conforming to IS 1239. The dimensional and other details shall be as specified in the enclosed Standard Drawings.
2) The street light poles shall have M.S pipes of progressively reduced dimensions and post top lanterns poles shall be of uniform cross section. The poles shall be treated with a rigorous rust inhibition process and the outside surface of the pole shall be painted with two coats of paint conforming to IS 2339. Erection of pole as per IS 5613 (Part I/Section 2-1985)

3) Where portion of the pole is required to be embedded in concrete and below ground, the inner circle shall be treated with two coats of bituminous paint.

4) The poles shall be complete with base plate of minimum size 300 x 300 mm and 10 mm thick, and as indicated in the standard drawing.

5) The pole below the ground level shall be grouted in 1:2:4 concrete as per standard drawing. The bottom portion of foundation shall be 800 x 800 mm.

6) Two nos. 50 dia. G.I pipes in arc with 600 mm radius shall be embedded in concrete pedestal upto marshaling box for running of incoming and outgoing cables.

7) Earthing studs shall be provided on pole. The earth wire may be run directly on D-clamp as per IS 5613 (Part I) section 2 –1985

8) Each pole shall be provided with a junction box made of 2 mm thick sheet steel mounted on supporting clamps welded to pole at +450 mm from ground level. The box shall be of weatherproof and dust tight construction with neoprene gaskets and provided with hinged front cover/door with key operated locking device. The box shall have overall dimension of 200 x 150 x 100 mm and shall be complete with the following: Alternatively, arrangement shall be for an integral type junction box as shown in drawing.

   8 way 30 Amp strip type terminals each terminal being suitable for termination of loop in and loop out of Aluminium conductor cables upto 25 Sqmm.

   ii) 10 Amps SPN (double pole) MCB.

   iii) Internal wiring from box to lamp holder of light fitting at top by means of 2 runs of
9) The gate lights installation shall be with 600 mm long MS pipe out of which 300 mm is embedded in compound/gate wall. The junction box shall be flush mounted in wall at +450 mm from ground level and with 19 mm dia. MS conduit interconnecting pole and junction box for running wires. The light poles shall be numbered with neat letters in paint.

10) The rate shall include all items/works described as above and including civil works, reducers suitable size foundation bolts as per standard drawing and any other items not specified but necessary for completion of installation.

1.38.3 Light Fittings:

The light fittings shall be of specified type and complete with polyester filled copper choke, HPF condenser holder, ignition, control gear, lamp/bulb of appropriate wattage and type, connectors, fuses etc. whether specified or not in the Bill of Quantities.

NOTE

1) The Contractor shall submit the drawings of the poles based on above specification and schedule for approval from the Consultant/Client before fabrication.

2) The civil foundation works of security and pathway lights have to be executed by the contractor including supply of all materials. The price for erection in schedule of quantities contain the cost of civil foundation.

1.39 TELEPHONE / DATA SYSTEM:

1.39.1 Scope

This includes MS conduit supply and laying, cable supply and laying and termination of Telephone outlets and LAN outlets, jack panel termination and rack fixing, ferruling testing, testing of the telephone and LAN system and submitting the test report to Employer.

1.39.2 Specification for Dummy Conduits, for Communication & Data System

1) The conduits for the telephone system as well as Intercom System and Data System shall be same as explained and specified elsewhere for other work. The minimum size of conduits used for Telephone System/Intercom shall be of 25 mm dia.

2) All distribution boxes shall be flush mounting, flat fronted, 16 Gauge sheet steel enclosed boxes flush with wall and properly joined to conduits. The distribution boxes shall
3) The telephone outlet boxes made of 16 Gauge sheet shall be of minimum 75 x 75 x 75 mm. These shall be flush mounting type installed with an approved cover matching with all other outlets in the electrical system and consisting of a CAT 5 RJ 45 outlet and approved by the structured data and communication cabling system.

4) The telephone boxes shall be generally mounted at 450 mm FFL unless otherwise specified/indicated in drawing.

5) The contractor shall consult and co-operate with the Consultant/Client when installing the telephone wiring and conduit system and shall abide by their requirements, rules and regulations, shall furnish all work and material to secure their approval of the completed installation.

6) The contractor shall submit detailed drawings showing the telephone terminal and junction boxes fabricated in accordance with above requirements and get approval from the Consultant/Client.

7) Rates shall include a GI fish wire left in the conduit to draw telephone wires. The end of conduit shall be sealed to prevent dirt, dust, mortar or any foreign matter going into telephone conduits.

8) The telephone indoor wires shall be 0.5 mm annealed tinned copper conductor, PVC insulated, twisted into pairs, laid up, taped and overall PVC sheathed, or CAT 5# UTP/STP cable.

9) The telephone outdoor cable shall be 0.5 mm annealed copper conductor, polythene insulated, color coded, twisted into pairs, laid up, jelly filled with petroleum jelly compound, wrapped with non-hygroscopic tape under moisture barrier poly al laminated foil tape and embedded with water proof polythene material.

10) Telephone system for the project shall consist of Private Automatic Branch Exchange (PABX) hardware and related software with required wiring. The PABX system is required to be an electronic microprocessor controlled system designed to be an universal telephone exchanges for all voice and data service required for the typical multiplex theatres with shopping and entertainment complex.

11) The switch shall be ISDN compatible making full use of ISDN services being offered or planned in future in the local telecom market. The switch shall be based on universal port architecture.

1.39.4 Backbone wiring
The function of backbone wiring shall be to provide interconnection between telecommunication closets in riser and equipment room in the telecommunication wiring system. The backbone wiring shall consist of the transmission media, intermediate and main patch panel on each floor and mechanical terminations for interconnections of telecommunication closet sand equipment rooms.

The backbone wiring shall use star technology wherein each telecommunication close shall be wired to a main cross connect / patch panel or an intermediate patch panel at then to a main patch panel, as case may be. There shall be no more than two hierarchical levels of cross connects I patch panel in the backbone wiring. For data system, where riser distance is more that 90 M, fiber optic backbone shall be used.

Care shall be taken to ensure that cross talk coupling between individual twisted p shall not affect the transmission performance of multipair cables.

1.39.5 Horizontal Wiring

The horizontal wiring shall be the portion of the telecommunication wiring system extends from the work area telecommunication outlets to the telecommunication closet. The horizontal wiring shall include the telecommunication outlet in the work area, the mechanical terminations for horizontal cables and cross connections located in telecommunication closet.

The horizontal wiring shall be of star technology with each work area telecommunication outlet connected to a telecommunication closet. The horizontal wiring shall be CAT copper conductor PVC wire drawn in G.I. conduit, generally run above false ceiling of floor separated from the electrical wiring in an appropriate manner so as to eliminate electromagnetic interference. Maximum distance of wire from mechanical termination the media in closet to outlet shall be limited to 90 meters.

RJ-45 patch panel shall be provided in the closet. All wires/cables shall be identified tags and schedule identifying each termination shall be submitted to the Client after completion of installation.

1.40 SPECIFICATION FOR LAN & WORK.

1.40.1 Code and Standards:

- TIA/EIA-568-B.2-1 Transmission Performance Specifications for 4-pair 100 Augmented Category 6 Cabling
- TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
1.40.2 General Requirements

1) The number of points of connectivity in each floor/wing as well as the exact distribution of the same in the faculty rooms/laboratories/conference rooms etc to be given sheet.

2) The number of points of connectivity in each floor/wing as well as the exact distribution of the same in the faculty rooms/laboratories/conference rooms etc to be given sheet.

3) The horizontal cabling will be 4 core unshielded twisted pair (utp) category 6 (Gigabit to the desktop) terminated with information outlets of either single or dual or quad depending on the requirement at the specific location.

4) Patch panels / jack panels should be provided along with the patch cords of adequate lengths conforming to the standards.

5) Cabling activity, for both copper and fiber optic includes all the associated material and related civil work as a total turn key solution. for example, cable pulling, connection of cables, crimping of cables, up to termination of nodes and the associated labour for fixing racks and panels etc.

6) The work related to the connectivity requirements in the main communication rooms as well as the floor level/wing level communication rooms will be within the scope.

7) After the cable plant is implemented completely, it has to be tested using appropriate tools to ensure that it meets all the stated requirements and the test reports have to be submitted.

1.40.3 Testing

After the cable plant is implemented completely, it has to be tested using appropriate tools to ensure that it meets all the stated requirements and the test reports have to be submitted to the Employer.

1.41 SPECIFICATION FOR PUBLIC ADDRESS SYSTEM

1.41.1 Scope of Work
The scope of work shall include designing, supplying and installing Public Address System. Appliances and labour necessary to install the said system, complete with Speakers, Amplifiers, Mike, Zone selection Panel for interfacing with other systems.

The PA System is designed to serve the dual purpose of making general announcement or to transmit the fire tone under fire condition.

1.41.2 System Design

The Speakers shall be distributed in the entire floor and shall be configured in different zones. The announcement can be made in zone wise or to all the speakers simultaneously in ALL CALL mode. Fire Alarm shall be announced immediately on receipt of Fire signal from the panel to all zones.

1.42.3 Amplifiers

1) All amplifiers shall be mixing type for combining speech and music.

2) The power amplifiers shall have adequate continuous (RMS) power output to meet the requirement of the configuration. The unit shall be capable of delivering the rated output watts with less than 0.05% harmonic distortion in the design band width. The amplifier shall have a broad band frequency response of 20 Hz to 20 KHz. The output voltage and impedance shall meet with the system requirements. Amplifiers shall be protected against over loads and output shorts and a special thermal overload on the heat sink.

3) The distributed audio amplifiers shall be magnetically coupled switch mode type with two input signal sources selectable manually or automatically by the fire alarm system. The amplifier shall incorporate a push-to-talk switch. Output wattage and volts shall be as shown in the schedule of work or as required to meet the needs of the PA System.

4) Power as well as audio amplifiers shall be mounted in suitable wall mounted / floor standing enclosures.

1.41.4 Speakers

1) Speakers shall be especially designed for broadcasting high quality, integrated emergency fire alarm signals and voice communications and approved by an appropriate authority for use in such situations.

2) Speakers shall be ceiling or wall mounted as shown in the schedule of work and shall be completed with mounting brackets accessories etc. Speakers shall be in wooden or metal enclosures.

3) Speakers shall be of high efficiency yielding maximum output at minimum power across

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
4) Speakers external appearance shall be approved by the Architects.

5) Speakers shall be interconnected in the zone configuration.

1.41.5 Zone Selection Panel

1) The user interface to the entire public address system shall be the Zone Selection Panel. It shall be able to address 10 zones.

2) The Panel shall have one Microphone for announcements. The selection of announcement is done through the Panel. The announcement/Fire tone can be made zone wise. The Control Panel shall have individual zone selection switches as well as ALL CALL switch.

1.41.6 Wiring

1) PA system wiring shall be done by 2 core x 0.75 sq. mm PVC insulated copper armoured cable.

2) The speakers in each zone are connected in parallel and are connected to the respective output. The cables from each zone are separately routed and terminated in the Panel.

1.41.7 Testing and commissioning

Entire PA System shall be tested to establish the following.

i. Functionality of the P A System

ii Combined systems shall be tested for the overriding feature for prioritising fire alarm and life safety requirements.

iii Acceptable audibility of the public address in all spaces and record sound pressure levels of the Public address vis a vis the ambient noise levels.

1.42 TECHNICAL SPECIFICATION FOR LIGHTNING ARRESTER

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
1.42.1 Code and Standards

IS : 2309 - 1989

Code of practice for protection of buildings and allied structures against lightning (Second revision)

1.42.2 Design

i. Optimal Protection against the direct effects of lightning.

ii. Improved maximum effectiveness and longevity.

iii. Total autonomy.

iv. Activates itself only when there is a risk of lightning.

v. Permanent single drop from the tip of the Air-terminal down to the earth.

vi. Full compliance with international standards - example the French Standard NF C1 7-102

vii. Reliability and Sturdiness to be tested by both International test laboratories and in Real- live lightning conditions, tested and witnessed by reputable authorities (for example, Atomic Energy Commission).

viii. Proven, Robust Design able to withstand Multiple Lightning Strikes.

ix. 5 Model Range offering customized solutions for each Project.

1.42.3 Scope

This specification covers the requirements of supply, installation, testing and commissioning of lightning protection system in conformity with the requirements of IS:2309, consisting of vertical air termination, horizontal air terminations, down conductors and earth stations.

1.42.4 Air Termination's.
The horizontal air terminations shall consist of a rigid network of tapes fixed to the surface of the roof. All exposed metal work and roof structures forming part of the structure to be protected shall be bonded to the network work by the conductors of the appropriate cross section.

1.42.5 Down Conductors

Air terminations shall be connected to the earth terminations by tapes fixed onto walls of the structures with spacers. The tapes shall be securely fixed to walls by means of brass saddles and metallic fasteners. Where the down conductors are laid underground, they shall be laid at a depth of 750 mm below the ground level, buried in trench, covered with a 100 mm thick layer of sand and protected by cable protection tiles.

All metallic parts of the building above the main roof level including ducts, towers, pipes, gutters and other mechanical equipment's shall be bonded to the down conductors.

1.42.6 General

1 The materials shall be free from rust, scale and other electrical and mechanical defects. The size, materials and quantity shall be as specified.

2 Steel earthing conductors above ground shall be hot dip galvanized. If painted it shall be given two coats of approved bit mastic paint/anti corrosive paint.

3 Test links in suitable enclosures shall be installed by the contractor at no extra cost for connection between each lightning conductor down conductor and earth electrode.

4 The scope of installation of lightning conductors on the roof of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying, fastening/cleating/welding of the down comers on the walls/columns of the building and connection to the test links above ground level, and up to earth station.

5 Lightning protection conductors shall not be connected to other general earthing conductors.

6 The lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during adverse weather conditions.

7 The down conductors shall follow a direct path to earth. There shall not be any sharp, turns and kinks in the down conductors.
9. Every down conductor shall be provided with a test link at about 1000 mm above ground level. The test link shall be directly connected to the earthing system/electrode.

10. The lightning protection system shall not be in direct contact with the underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment's.

11. Lightning conductors shall not pass through or run inside G.I conduits.

12. Wherever required, if indicated in drawings, for fuel oil and other inflammable liquid storage tanks lightning and protection shall be provided with horizontal conductors strung between tall poles covering the entire areas.

1.45.7 Joints Bonding

The system shall have preferably no joints and they shall be made mechanically and electrically strong and effective. Bolted joints should only be used on test points or on bonds to existing metal. Generally jointing/connections/installations shall be as in earthing system.

1.45.8 Earth Terminations

Suitable number of earth terminations shall be provided. The earth termination shall consist of pipe/plate earth electrode as specified elsewhere in the Earthing Specification, and generally conforming to IS : 3043. The earth terminations shall be complete in all respects with chamber and cover, etc. as per the detailed specifications.

Before installing the lightning protection system, the contractor shall obtain approval from the Engineer with respect to the locations of air termination's and the routes for the down conductors.

1.45.9 Test Clamps/Links

Test clamps/links shall be manufactured from phosphor bronze or approved equivalent with four fixing holes. Tape conductors shall be fixed to flat roof surfaces by means of suitable fixing arrangement as approved.

All fixing screws shall be brass.
1.45.10 Testing:

Suitable testing links be provided at required points as per the code of practice CP 326/IS 2309. The contractor shall carry out tests on completion of the installation and submit the readings for approval.

1.46 SPECIFICATION FOR BUS DUCT

1.46.1 Rating

Bus Duct shall be of rated Current capacity and designed for an ambient temperature of 40 deg C and a temperature rise of 45 deg C above ambient.

1.46.2 Construction:

Bus duct shall be made of 14 SWG CRGA sheet. Bus duct shall be of non-segregated, dust, Vermin proof, Outdoor type with IP-65 protection. Bus duct shall be rectangular cross section.

All sheet steel shall undergo seven tank process treatment for degreasing, de rusting and phosphate followed by epoxy powder coating of RAL 7032 shade (Siemens gray). Bus duct dimensions should be coordinated with Transformer Marshalling box and Main L.T Panel. 90 deg. bends should be consider as per site requirement and will be finalized within 15 days from the date of finalization of order.

1.46.3 Marking of bus-bar and Main Connections

For Making Bus bars and main connections the following colours or Letters or both as given in IS: 375 shall be used

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Bus Bar Main Connections</th>
<th>Colour</th>
<th>Letter or Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Three Phase</td>
<td>Red, Yellow &amp; Blue</td>
<td>RYB</td>
</tr>
<tr>
<td>2</td>
<td>Two Phase</td>
<td>Red &amp; Blue</td>
<td>RB</td>
</tr>
<tr>
<td>3</td>
<td>Single Phase</td>
<td>Red</td>
<td>R</td>
</tr>
<tr>
<td>4</td>
<td>Neutral Connection</td>
<td>Black</td>
<td>N</td>
</tr>
<tr>
<td>5</td>
<td>Connection to Earth</td>
<td>Green</td>
<td>E</td>
</tr>
<tr>
<td>6</td>
<td>Phase Variable(such as in connection to reversible motor)</td>
<td>Gray</td>
<td>Grey or GY</td>
</tr>
</tbody>
</table>

146.4 Material

Bus Bars should be of E91 E grade Aluminum with a maximum current density of 0.8A/sqmm.
1.46.5 Tests

1) ROUTINE AND TYPE TEST
   Type test certificates and results as per relevant Standards (specification) for all the equipment offered under the scope of this specification shall be furnished.

2) All routine tests on all major components shall be made as per relevant specification

1.46.6 Inspection

Client / Consultant inspection of the bus duct for physical & functional checks before dispatch should be arranged by the tendered. The cost of transport and incidental expenses to be borne by the tendered. Two weeks clear notice to be given for carrying out the inspection.

1.46.7 Dielectric Tests

1) Insulation resistance of the main power circuit like between phase to phase, phase to neutral and phase to earth shall be measured.

2) Insulation resistance to earth of control wiring should be tested with 1000 V megger.

3) Insulation test shall be carried out both before and after high voltage test.

4) All current carrying parts and wiring shall be subjected to a high voltage test.

1.46.8 High Voltage Test

A high voltage test with 2.5 KV for one minute shall be applied between the phases, phase to neutral and phase to earth. Test shall be carried out on each phase in turn with the remaining phases earthed. All units racked in position and the breakers closed. Originals test certificate shall be submitted along with panel.

APPROVED MAKE OF MATERIAL

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Materials</th>
<th>Manufacturer/Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Item Description</td>
<td>Brand(s)</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>HT Cable Termination Kit</td>
<td>Raychem</td>
</tr>
<tr>
<td>2</td>
<td>HT Cable</td>
<td>Fort Gloster / CCI / Torrent / Finolex / Asian</td>
</tr>
<tr>
<td>3</td>
<td>LT Power, Control and Signal Cables</td>
<td>Finolex / Polycab / Torrent / CCI / Fort Gloster / Asian</td>
</tr>
<tr>
<td>4</td>
<td>LT BUS DUCT</td>
<td>L&amp;T / Godrej</td>
</tr>
<tr>
<td>5</td>
<td>ACB</td>
<td>Siemens / Crompton / Schneider</td>
</tr>
<tr>
<td>6</td>
<td>MCCB</td>
<td>Siemens / L&amp;T / Merlin Gerin</td>
</tr>
<tr>
<td>7</td>
<td>MCB</td>
<td>Legrand / Siemens / Hager</td>
</tr>
<tr>
<td>8</td>
<td>Capacitors (APP/Gas filled)</td>
<td>ABB / EPCOS / Siemens</td>
</tr>
<tr>
<td>9</td>
<td>UV / OV / ELR</td>
<td>Minilec / Prok Devices / AVR Electronics</td>
</tr>
<tr>
<td>10</td>
<td>Cable Glands – Double Compression Type</td>
<td>Dowell / Comet / HMI</td>
</tr>
<tr>
<td>11</td>
<td>Cable Lugs</td>
<td>Dowell / Multi / Uma</td>
</tr>
<tr>
<td>12</td>
<td>Switch Disconnector Fuse Unit</td>
<td>Siemens / L&amp;T</td>
</tr>
<tr>
<td>13</td>
<td>Load Break Change over SFU / Isolator</td>
<td>Siemens / L&amp;T</td>
</tr>
<tr>
<td>14</td>
<td>HRC Fuses / Fuse Base</td>
<td>Siemens / English Electric / L &amp; T</td>
</tr>
<tr>
<td>15</td>
<td>Earth Leakage Relay / CBCT</td>
<td>Prok-DVS</td>
</tr>
<tr>
<td>16</td>
<td>PF Relay</td>
<td>EPCOS / ABB / L &amp; T</td>
</tr>
<tr>
<td>17</td>
<td>Protective Relays</td>
<td>L&amp;T / Alsthom / Easun / Siemens</td>
</tr>
<tr>
<td>18</td>
<td>Selector Switches</td>
<td>Kaycee / L&amp;T / Salzer</td>
</tr>
<tr>
<td>19</td>
<td>Meter – Ammeter and Voltmeter (Analog Type)</td>
<td>AE / Meco / Rishab</td>
</tr>
<tr>
<td>20</td>
<td>Indicating Lamps / Push Buttons:</td>
<td>Technik / Vaishno / ABB / Schneider / Siemens</td>
</tr>
<tr>
<td>21</td>
<td>CT’S – Resin Cast</td>
<td>Voltamps / Kappa / Kalpa</td>
</tr>
<tr>
<td>22</td>
<td>Contactors / Overload Relays / MPCB</td>
<td>Siemens / L&amp;T</td>
</tr>
<tr>
<td>23</td>
<td>Indicating True RMS Meter (DIGITAL TYPE)</td>
<td>Conzerv / HPL Socmac / Rishab</td>
</tr>
<tr>
<td>24</td>
<td>Industrial Power Socket Outlets (Metal Clad)</td>
<td>Crompton / MDS / Cutler Hammer</td>
</tr>
<tr>
<td>25</td>
<td>MCB Distribution Boards</td>
<td>Legrand / L&amp;T-Hager</td>
</tr>
<tr>
<td>26</td>
<td>Domestic Switches &amp; Sockets / Fan Regulators (MODULAR TYPE) Sample to be approved</td>
<td>MK / Anchor – Roma / Crabtree</td>
</tr>
<tr>
<td>27</td>
<td>Telephone &amp; LAN Sockets</td>
<td>D-Link / Tyco</td>
</tr>
<tr>
<td>28</td>
<td>Light Fittings (Industrial / Commercial</td>
<td>Philips / Wipro / Bajaj / Crompton</td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
<td>Brand/Make</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>29</td>
<td>Light Fittings (Decorative / Architectural)</td>
<td>Artlite / Pasolite / Thorn / Reiz / K-Lite / Havells</td>
</tr>
<tr>
<td>30</td>
<td>Ceiling Fans 5 star rated</td>
<td>Usha / Bajaj / Havells</td>
</tr>
<tr>
<td>31</td>
<td>Exhaust Fan</td>
<td>Crompton / Almonard</td>
</tr>
<tr>
<td>32</td>
<td>Wall Mounted Fans</td>
<td>Almonard / Crompton</td>
</tr>
<tr>
<td>33</td>
<td>FRLS Wire</td>
<td>Finolesx / Polycab</td>
</tr>
<tr>
<td>34</td>
<td>FRLS PVC Conduits &amp; Accessories (Heavy duty only)</td>
<td>VIP / National / Nelco</td>
</tr>
<tr>
<td>35</td>
<td>MS Conduits &amp; Accessories</td>
<td>GI Bharat / Supreme / Javeri / BEC / BIS approved</td>
</tr>
<tr>
<td>36</td>
<td>Perforated &amp; Ladder type Cable Trays</td>
<td>Elcon / Profab / Patni</td>
</tr>
<tr>
<td>37</td>
<td>Raceways / PVC Trunking</td>
<td>Schnedier / Honeywell / Legrand</td>
</tr>
<tr>
<td>38</td>
<td>Batteries SMF Type</td>
<td>Exide</td>
</tr>
<tr>
<td>39</td>
<td>Battery Charger</td>
<td>Universal / Abhay Electric</td>
</tr>
<tr>
<td>40</td>
<td>Telephone Connector Terminal Box</td>
<td>KRONE</td>
</tr>
<tr>
<td>41</td>
<td>Telephone Cables Jelly filled Armored Paired Cables</td>
<td>Delton / Finolesx / Polycab / Havell</td>
</tr>
<tr>
<td>42</td>
<td>Telephone cabling system</td>
<td>TATA Telecom / Siemens / Lucent / D-Link / Adonix / Molex</td>
</tr>
<tr>
<td>43</td>
<td>LAN Data cabling system</td>
<td>Tyco</td>
</tr>
<tr>
<td>44</td>
<td>RJ45 Patch Panel</td>
<td>Tyco</td>
</tr>
<tr>
<td>45</td>
<td>Communication Rack</td>
<td>APW – President</td>
</tr>
<tr>
<td>46</td>
<td>Street Light Pole</td>
<td>Baja / Metal Coats (K-LITE)</td>
</tr>
<tr>
<td>47</td>
<td>PA System</td>
<td>Philips / Ahuja</td>
</tr>
<tr>
<td>48</td>
<td>Safe Earth Electrode</td>
<td>Aslok Safe Electrode Type T-39Z</td>
</tr>
<tr>
<td>49</td>
<td>Flameproof / Increased Safety Switchgear &amp; lighting fixtures</td>
<td>Flameproof Equipment P Ltd / Sudhir Switchgear / CEAG / Baliga</td>
</tr>
<tr>
<td>50</td>
<td>Steel</td>
<td>TATA / Vizag / Jindal</td>
</tr>
</tbody>
</table>

**General**

1) Detail submittals in the form of catalogues specification sheets, and samples were called for, shall be submitted one week from the date of order and approvals shall be obtained on the type of accepted make before procurement are made.

2) Out of the approved makes of materials mentioned above, the make of materials to be used on the work shall be as decided by the Consultant/Client jointly.

3) In respect of materials for which approved makes are not specified above, the material makes to be decided by the Consultant/Client jointly and as per sample approved before procurement.
4) Equipments approved and supplied shall have local servicing facilities available in the region.

5) In case of non availability of the first indicated makes, the contractor shall opt for the other makes after getting approval from the Consultant/Client jointly. If the difference of amount is on the lower side, the same shall be passed on to the Clients.

AIR CONDITIONING & VENTILATION SYSTEM

TABLE OF CONTENTS

INDEX

SECTION 1 : GENERAL REQUIREMENTS
SECTION 2 : CHILLERS
SECTION 3 : WATER PUMPS & COOLING TOWERS
SECTION 4 : HVAC EQUIPMENT
SECTION 5 : DUCTWORK
SECTION 6 : FIRE DAMPERS
SECTION 7 : DUCT WORK INSULATION
SECTION 8 : MEASUREMENTS
SECTION 9 : PIPING
SECTION 10 : PIPING INSULATION
SECTION 11 : ANCILLARY ITEMS
SECTION 12 : TESTING, ADJUSTING AND BALANCING
SECTION 13 : ELECTRICAL WORKS
SECTION 14 : PLC CONTROL SYSTEMS
SECTION 15 : FIELD DEVICES
SECTION 16 : LIST OF APPROVED MAKES
SECTION-1

GENERAL REQUIREMENTS

3.1.1 GENERAL.

These specifications are for the HVAC works only. However, the Instructions to Tenderers, Form of Tender, Conditions of contract, Note on Pricing, Preliminaries Section and any Supplementary Conditions of Contract applicable to Main Contract shall be applicable to this contract also.

The terms Contractor and Subcontractor used in these documents and drawings are to be considered to be meant as Contractor for HVAC works.

3.1.2 INTENT.

Contractor shall be responsible for proper performance of all HVAC systems in accordance with relevant IS standards and codes and design parameters listed hereinafter. Contractor shall ensure that execution of total work is in accordance to this.

Provide all items, articles, materials, operations, sundries, labour, supervision, guarantees, allowances for overhead and profit, etc., to achieve a fully functional and acceptable.

The precedence of documents and drawings shall be as determined in the Main Contract. However, considering the specifications as an integral part of the work together with the drawings and any item or subject omitted from one, but mentioned or reasonably implied on the other as properly and sufficiently indicated and provide the same under the work.

The Contractor is responsible for developing his own take off of materials and is to make available as approved by Consultant /Client.

3.1.3 EXAMINATION OF SITE AND DRAWINGS.

Visit the site of the proposed works and obtain all information assess the existing conditions and limitations and all proposed works on adjacent sites and in adjacent areas which might affect the works on this site, whether by Private Individuals or by Government Authorities or others.

Examine the documents including the Specifications and Drawings of all before bidding and again before commencing any portion of the work.

Neither Client nor the Consultant shall be responsible for any claim for extra work or expenses resulting from the failure of the Contractor having fully aware of Site Conditions.

3.1.4 PERMITS FEES AND INSPECTIONS.

Arrange for inspection of all works by the external agencies as and where applicable. This is to occur on an on-going basis throughout construction to avoid delays to the project.

Pay fees/charges as levied by the Local Authorities for inspections, approvals, temporary services, connections, etc. at no additional cost to contract.

3.1.5 CONTRACT DRAWINGS

The drawing, specifications and bill of quantities shall be considered, as a part of this contract and any work or materials shown on the drawings and not called for in the specification or vice-versa, shall be executed as if specifically called for in both.

The drawings for services works are design drawings, diagrammatic, and intended to convey the scope of work and indicate general arrangement and approximate locations of equipments, fixtures, pipe and duct

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Any discrepancies, which in his opinion appear on them, have to be reported to the consultant/Client and get them clarified. He shall not be entitled to any extras, for omissions or defects HVAC drawings or when they conflict with other work.

Do not scale drawings. Obtain accurate dimensions to structure and architectural items from drawings of those trades. Confirm by site measurement. Verify location and elevation of all services before proceeding with the work.

Make at no extra cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (pipes or ducts around beams, columns, etc.)

Install all ceiling mounted components (Diffusers, grilles etc.) in accordance with the reflected ceiling drawings, which are to be prepared by the Contractor, and coordinated with all trades/agencies engaged at site. These must be submitted for approval and be approved before any work commences on site.

Leave space clear and install all work to accommodate future materials and/or equipment as indicated and/or supplied by other agencies of work of the contract. Install all pipe runs, conduit runs, cable trays, etc., to maintain maximum headroom and clearances, and to conserve space in shafts and ceiling spaces and under floors, and to provide adequate space for service and maintenance.

Confirm on the site the exact location of outlets and fixtures.

3.1.6 SHOP DRAWINGS, BUILDER’S WORK DRAWINGS AND MATERIAL SUBMITTALS

After award of Contract, submit programme of works in bar chart schedule and action plan along with the programme, submit a schedule detailing proposed submission dates for all Material Submittals, Shop drawings and Builder’s work drawings. Allow few days to review by the Consultant/Client for each such submission.

Contractor must obtain, from the Consultant/Client, approvals of all materials, equipment and drawings within appropriate time to facilitate progress of work at site.

Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for all passages through structure and all insert sizes and locations.

Prepare composite construction drawings, fully dimensioned, of piping and equipment in shafts, mechanical equipment rooms and areas, and all other critical locations to avoid any conflict arising thereof.

Shop drawings should include all details pertaining to access, cleanouts, tappings, sleeves, electrical connections, drains, location and elevation of pipes, ducts, conduits, etc., obtained from consultation with, and agreement of, all trades involved.

Prepare drawings of equipment foundation or support as the case may be. Prepare drawings for the support of ducts, pipes, electrical cabling with all details. Drawings for wall openings, trenches etc must be submitted for approvals.

Prepare all drawings to scale as agreed with the Consultant/Client. Generally, the scale shall be 1:50 for layouts and 1:20 for Details and Sections, etc. Forward these drawings, approved by all trades concerned to the Consultant /Client for review/records.

The Consultant/Client will only consider shop drawings bearing the stamp of the Contractor and all Subcontractors involved, check for all pertinent information such as physical dimensions, make, performance, electrical characteristics and indicate the intended use and location before submitting these drawings.

Assume responsibility for accuracy of equipment dimensions related to space available, accessibility for maintenance and service. Ensure that shop drawings indicate working weights of all related equipments.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Submission of technical submittals for all equipment and materials covered in the contract to be made upon finalization of the contract for approvals of Consultant/Client. The submission of samples, wherever raised by Consultant/Client, will be subject to the same procedure as that of shop drawings. One set of such samples shall be required to be brought and kept at site till completion of entire work.

The Consultant/Client will mark the drawings "Approved / Approved with comments / Revise and Resubmit / Not Approved. Same practice will be followed for the material submittals. Contractor will take action based on the comments accordingly.

The Consultant's/Client review shall not relieve the Contractor from responsibility for deviations from the Contract documents, unless he has, in writing, called the Consultant's/Client attention to such deviations at the time of submission of drawings. The Consultant's/Client approval shall not relieve the Contractor from the entire responsibility. Any approval by the Consultant/Client shall be on the understanding that any item submitted shall be ordered with options and modifications to fully meet the specification. Any fabrication, erection, setting out or other work done in advance of receipt of stamped drawings shall be done entirely at the Contractor's risk and cost.

Contractor shall submit one complete set of original drawings, as built drawing with updated details as per site conditions.

Contractor shall indicate foundation, water supply & electric power supply for HVAC equipment on drawing and same shall be coordinate with other respective agency in coordination with Consultant/Client before execution of work.

Furnish prints of the reviewed details to all other parties who may require them for proper coordination of their work, and furnish all information necessary for the work as a whole.

Obtain Manufacturers' installation directions to aid in the proper execution of the work.

3.1.7 OPERATION AND MAINTENANCE MANUALS

Upon successful Testing & commissioning, submit one draft of Operation and Maintenance Manuals for review and approval of Consultant/Client.

The minimum information required is as follows:

(a) Catalogs highlighting the Make, Model, Sr. No and other necessary details for all Material, test certificate, Manuals and Equipment installed.
(b) List of Local Agent / Supplier for all Materials and Equipment with Telephone, Fax and Email address.
(c) Detailed description of systems operation.
(d) Procedures for Preventive regular and the breakdown maintenance, with Manufacturer's Operation and Maintenance Catalog for all Systems / Equipments.
(e) Commissioning date for all Systems / Equipment.
(f) List of recommended spares.
(g) Trouble shooting – Cause / Remedy charts.
(h) Safety procedures.
(i) Startup / Shutdown interlock sequence.
(j) Emergency / Shutdown log sheet format.

Upon approval of the draft by the Consultant, submit 4 set of manuals to Consultants for onward submission to Client.

3.1.8 COOPERATION

Confer with all trades installing equipment, which may affect the work, and arrange equipment in proper relation with that equipment installed under all Divisions of the Contract.

Furnish all items to be built in by others, in time, complete with all pertinent information, commensurate with the progress of the work.

Store materials neatly and out of the way and clean up all refuse caused by the work daily, to ensure that it does not disturb or hamper the work of other agencies.
3.1.9 PROTECTION AND STORAGE

Protect the buildings and structures from damage due to carrying out of this work.

Protect all mechanical & electrical works from damage. Keep all equipment dry and clean at all times.

Cover all openings in equipment and materials. Cover all temporary openings in ducts and pipes with polyethylene sheets or caps until final connection is made.

Any damages to the equipment and material resulting from improper protection and storage arrangement made by contractor will have to be made good at his own cost, failing which the same be liable for rejection.

Due care must be exercised while installation/erection of equipment and material, to avoid damages to the equipment and material mentioned in this division and the work/material of other agencies.

Contractor to include for all necessary insurance coverages for their workers & material at site, copies of the same be produced prior to commencement of work.

3.1.10 EXISTING WORK AND EQUIPMENT

Before Contractor undertakes work in any area he must prepare a list of deficiencies in that area which affect his works, or which could possibly be construed as being caused by himself if not noted. In the event that such deficiency list is not prepared, then he shall be deemed responsible for such deficiencies. Any list shall be brought to the attention of the Consultant/Client forthwith.

3.1.11 SUPERVISION.

The contractor will maintain at site, as necessary for the performance of the Contract, qualified personnel and supporting staff, with proven experience in erecting, testing, and adjusting projects of comparable nature and complexity. Such staff will be fully dedicated to the project and be available at site for continuous supervision activities.

Before commencing work the Contractor will submit details of the proposed Engineers and Supervisors, including copies of their qualification and experience Certificates. If in the Consultant's/Client opinion the proposed Engineers or Supervisors are not adequately qualified or are otherwise unacceptable, the onus is on the Contractor to submit alternates until such approval is given.

Where the Contractor's staff becomes during the Contract deficient in performance, the Contractor is to remedy the situation by immediate and appropriate replacement, to Consultant's/Client approval.

Approval of the Contractor's Engineers or Staff shall in no way prevent the withdrawal of that approval at any time during the Contract should the Consultant /Client so desire. In the event of such disapproval, Contractor will be required to rectify the position as stated above.

In the event of any negligent or severely detrimental behavior the Consultant /Client has the right to order the removal from site of any Engineer, Supervisor, or worker on a "forthwith" basis.

3.1.12 WORKMANSHIP.

Good workmanship and neat appearance are the prerequisites for completion with the various sections of this specification. Work shall carried out in accordance with the statutory rules and conform to relevant rules and I.S Specifications.

Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the satisfaction of the Consultant/Client. Install ducts and pipes parallel and perpendicular to the building planes. Install all piping and ductwork concealed in chases, behind furring, or above ceiling, except in unfinished areas. Install all exposed systems neatly and group to present a neat appearance.

Install all gauges, thermometers, etc., to permit easy observance.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Install valves to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.

Install all panels and boards, etc., to permit easy operation.

Include in the work all requirements of Manufacturers as shown on their drawings.

Replace all work unsatisfactory to the Consultant/Client without extra cost and to the standard required by the Consultant/Client. This applies to any item, which is found to be defective in service during the maintenance period, or extended maintenance period as appropriate.

If the contractor employs sub-contractors for works like equipment installation, ducting, piping, insulation etc., the same is to be communicated in advance to the consultant/Client with a detailed profile of the sub-contractor including their experience, skilled personnel and machine/tools availability for undertaking such works. The sub-contractor can start work only after acceptance / clearance issued by consultant/Client.

3.1.13 MATERIALS AND EQUIPMENT.

All materials used on the project shall be brand new and in compliance with the technical specification mentioned in the contract. Equipment/material Manufacturers mentioned in the list of makes alone will be accepted. Obtain approval of all manufacturers from the Consultant/Client. Contractor is advised not to submit any brand, which does not appear in the “List of approved makes”.

"New" is defined as newly manufactured, and delivered to site as such. Any Equipment which in Consultants/Client opinion second hand or has been mishandled before delivery to site, shall be rejected.

All materials used on this project shall bear the third party quality assurance stamp like British Standard kitemark, UL, FM, and/or other quality assurance authority as appropriate, in the opinion of the Consultants.

Each equipment should be factory tested and certified all QA/QC test certificates to be submitted for review of consultant. If deemed necessary factory inspection may be undertaken by consultant /client.

Each equipment should be properly tagged, with name plates carrying all details relevant to the machine for ease of identity and reference.

3.1.14 CLEANING.

Each day as the work proceeds and on completion, clean up and remove from the premises all rubbish, surplus material, equipment, machinery, tools, scaffolds, and other items used in the performance of the work. Clean out dirt and debris and leave the buildings broom clean with no stains and in a condition acceptable to the Consultant/Client.

Where electrical items form part of the visible finish in the rooms, protect from over-painting, etc. and give all items a final cleaning before handing over of the project.

3.1.15 ACCESSIBILITY.

Each item of equipment shall be located so as to be accessible for maintenance or repair without removing adjacent structures, equipment, piping, ducts, or other materials. For the large Air Handling units the Contractor shall ensure that these can be built up on site from components, which can be taken into the area.

Any item of equipment needing maintenance shall be located so as to be accessible for maintenance or repair without removing adjacent structures, equipment, piping, ducts, or other materials.

3.1.16 CUTTING AND PATCHING.

Inform all other Divisions in time concerning required openings.
Obtain the approval of the Consultant/Client before doing any cutting. Supporting members of any floor, wall or the building structure shall only be cut and in such a manner as approved by the Consultant/Client. All reinstatement work must be done to the same standard as the original work.

3.1.17 INSERTS, SLEEVES AND CURBS.

Under this section supply necessary sleeves and other inserts to other trades.

Use only factory made, threaded or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. Place inserts only in portions of the main structure and not in any finishing material.

Supply and locate all inserts, holes, anchor bolts, and sleeves in good time when walls, floors, and roof are erected.

Pass insulation unbroken where pipe or duct is insulated. Size sleeves to provide adequate clearance all around.

Use the following materials for pipe sleeves:

a) Through all interior walls above grade use PVC Class 150 pipes, machine cut, flush with finished structure.

b) Through all exterior walls above grade use PVC Class 150 pipes, machine cut, flush with finished structure inside and to suit flashing on outside.

c) Through all exterior walls below grade and all other waterproof walls use PVC Class 150 sleeves, machine cut. Check flashing specification for further details.

d) Through all waterproof floors, janitor's closets, mechanical rooms, kitchens, roofs, use PVC Class 150 sleeves, machine cut. Extend sleeves 100 mm above finished floor upwards and cut flush with underside of floor. Refer to flashing detail through waterproof floors.

e) Provide 100 mm high, 100 mm wide watertight concrete curbs with 20 mm chamfered edges around all pipes passing through waterproof floors except where furred in. Read Concrete specification before proceeding with curbs.

Pack all sleeves between the insulated pipe and the sleeve or where un-insulated between the pipe and the sleeve with loose fiberglass insulation. Seal the annular space as follows:

a) For all horizontal sleeves in exposed areas, use a seal equal or better fire rated than the wall to be sealed.

b) For all vertical sleeves through roofs, janitor's closets, equipment rooms, use permanently resilient silicone based sealing compound, non-inflammable and waterproof. Ensure that the seal is compatible with floor and ceiling finishes. Check the room finishing schedules for further details and clarify if necessary with the Consultant.

c) Through roofs, provide curbs and sleeves as shown on drawings and to suit flashing requirements.

Use the following sleeving for ducts:

For rectangular duct openings through walls and floors a removable hardwood box-out shall be provided of the required size. Soft wood or plywood will not be acceptable.

Wherever applicable, through fire walls, build fire dampers into wall, or make detailed fixing in accordance with Consultant's/Client instruction.

Through floors where ducts are not furred in or enclosed in a ductshaft, provide 100 mm high and 100 mm wide watertight concrete curbs, with 25 mm chamfered edges all around. Extend sleeves where used flush to top of curb. Read Concrete Specification before proceeding. Through floors where duct is enclosed in a duct shaft or furred in, provide the watertight curbs at the extreme top and bottom only.
a) Use fiberglass insulation for packing.

b) Seal the packing in openings through floors with permanently resilient silicone base non-inflammable waterproof compound. Press duct supports firmly down into caulking before bolting it down to curb.

c) Through all vertical walls seal the fiberglass packing using permanently resilient silicone based sealant.

Brace duct sleeves and box-outs to retain their position and shape during the pouring of concrete and other work.

Provide bracing for each duct at every passage through structure to prevent sagging.

3.1.18 ACCESS PANELS AND DOORS.

Install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on as-built drawings.

Provide the respective Division of work with panels, doors or frames, complete with all pertinent information for installation.

Ensure that access doors are installed in a manner to match the building grids where applicable.

Prepare detail drawings showing location and type of all access doors in coordination with other trades before proceeding with installation and hand these to the Contractor to obtain approval.

Size all access doors to provide adequate access and commensurate with the type of structure and Architectural finish. Should it be necessary for persons to enter, provide a minimum opening of 600 x 450 mm.

Ensure proper fire rating of access doors in fire separations

Lay-in type ceiling tiles, if properly marked may serve as access panels.

3.1.19 GENERAL WELDING REQUIREMENTS.

All welding shall be generally in accordance with ANSI B31.

Tack welds shall be performed by fully qualified welders and all tack welds shall be of a length equal to twice the pipe thickness and shall fully penetrate the pipe walls wherever required.

Where welding is carried out in the proximity of inflammable materials special precautions shall be taken to prevent risk of fire or other damage to the building fabric.

Where oxyacetylene cutting equipment or any welding plant is being used by an operative for any of the works defined in the contract documents, then fire extinguishers shall be supplied and carried as part of the equipment. The operators of cutting and welding equipment shall be trained in the use of the fire extinguishers, which they carry and all extinguishers shall be fully charged and ready for use. In all cases, extinguishers shall be positioned immediately adjacent to the position where cutting and welding is being carried out and shall be readily accessible for use in the event of an emergency.

All accommodation, benches, tools, welding plant, acetylene, oxygen or electricity, filler rods and electrodes, which are necessary for installations where welding is required shall be provided as part of this contract.

Welding shall not be done at a temperature of 5 degrees Centigrade or below unless the parent metal is preheated by torches or other approved means until it is warm to the hand (about 27 degrees C) for about 150mm either side of the joint. No welding shall be done below minus 18 degrees C. After preheating, the heated portion including the welded joints shall be covered with muffs or suitable insulation materials to allow cooling free from draughts. Any open ends of the pipe or assembly shall be effectively sealed to prevent heat flow by convection.

SIGNATURE OF TENDERER WITH SEAL

All welded pipe assemblies shall be constructed so that individual welded joints do not affect each other. The distance between the centres of adjacent welds shall be not less than twice the bore diameter of the pipe.
No welded joints shall be left partially completed. Any joints tacked in position must be promptly finished within the working day. The Consultant/Client will reject all work not done in accordance with this instruction.

Where work is rejected, pipes must be machine cut at least 150 mm either side of rejected welds and proper weld preparation must be used on the shortened sector. Where shorter fill-in sections are required because of such rejection and reworking, then new full sized lengths must be supplied by the Contractor.

Where pipes with longitudinal seams are specified, pipe seams shall be arranged such that adjacent seams are opposed 45 deg. from each side of top dead centre and branches shall be made only with weldable fittings.

All filler metals which are coated shall be protected from excessive moisture changes. Filler materials or flexes which show any sign of deterioration shall not be used. If requested by the Consultant /Client samples of filler rods to be used shall be submitted to him for approval before any work is done on site.

3.1.20 TESTS FOR WELDER QUALIFICATION.

The purpose of the welder’s qualification tests is to determine the ability of the welders to make sound and acceptable welds. Before any site welding on the contract is allowed, each proposed welder shall carry out the tests required in the presence of the Consultant/Client.

Any weld test specimens which have been suitably marked and approved shall be kept on site by a responsible person, so that they can be produced at any time, at the request of the Consultant/Client.

All accommodation, benches, tools, welding plant, acetylene, oxygen, electricity, test pieces, filler rods, electrodes, facilities for cutting and grinding, polishing, bending and examining, which are necessary for welders qualification tests shall be provided by the Contractor. In the absence of any items for inspecting the welds, the Consultant/Client may submit the finished samples to an independent laboratory for testing at the Contractor’s expense.

Under no circumstances shall a welder be employed on the contract, either on or off the site for welding operations other than those for which that welder is qualified.

Copies and records of all test reports shall be promptly given to and kept by the Consultant further submission to Client.

Even welders holding a certificate for welding are to be tested at this job site in full accordance with the specifications.

The Contractor shall be responsible for the quality of welding and brazing and shall provide the testing of the welders employed. Certificates of such proficiency test, together with stamped samples provided for Engineer’s review before welding work is commenced.

Qualification tests certified by consultant will be made for butt and branch welds in pipes. One test piece per welder will be required for the qualification of welding of pipes exceeding 100m nominal diameter.

In addition, test pieces will be required for each position of a pipe. These positions will be horizontal and rotated while welding, horizontal and fixed while welding, vertical and fixed while welding for each range of nominal diameters specified.

3.1.21 PAINTING AND IDENTIFICATION.

All painting of plant, equipment, storage vessels, ducting, pipes, refrigerant piping, and the like shall be carried out by contractor.

Painting shall be applied to all exposed pipe work, ductwork and associated components, valves, fittings, etc., equipment, supports of any kind, insulation, plain mild steel, copper, or cast iron surfaces, refrigerant piping. Steel piping shall be painted even if to be insulated, before insulation is carried out.
Il the refrigerant & water piping should be painted as per the standard colour code.

The following items do not require site painting:

(a) Insulation having any of the following finishes:
   (1) Aluminum foil.
   (2) Metalwork.
   (3) Polyisobutylene sheeting/bitumen coating.
   (4) Vinyl-glass/resin-aluminum foil laminate.

(b) Equipment or plant or supports or frames delivered to site with any of the following finishes:
   (1) Painted finish, other than primed only, provided that the finish is not damaged in any way.
   (2) Stainless steel or plastic coated steel.
   (3) Stoved enamel.

All surfaces to be painted shall be prepared by thoroughly cleaning and removing all rust, grease, oil, dirt and surface corrosion, using wire brush, emery paper and/or degreasing medium as required. The paint shall be applied in accordance with the maker's instructions and the type of paint to be used shall be in accordance with the following:

For factory applied finishes, repainting or refinishing of any surfaces damaged during shipping, erection or construction shall be done using only factory-supplied materials.

After finished painting is completed, identify each piped and ducted service. Locate identification and flow arrows:

(a) Behind each access door.
(b) At each change of direction on all joining pipes and ducts.
(c) At not more than 10 meters apart in straight runs of exposed pipes and ducts, but on both sides of sleeves.
(d) At not more than 10 meters apart in straight runs of pipes and ducts behind removable enclosures such as lay-in ceiling but on both sides of sleeves.
(e) Above each floor or platform for vertical exposed pipes, preferably 1.5 meters above floor or platform level.

P.V.C. tape identifying bands may be used as an alternative.

Use stencils and stencil paint onto all piping and ductwork. After completion of the works provide to Owner usable stencils for each service. Use wording shown in the description section of the legend on the Mechanical Drawings, or as instructed in writing by the Consultant/Client.

Wherever insulation is to be painted, the paint used shall comply with all the fire resistance requirements for insulation finish, and shall be carried out by the insulation subcontractor.

In all cases the actual grade of paint to be used shall be suitable for the operating surface temperature and shall be approved by the maker for the application concerned. In certain cases the grade of finishing coat may not require the application of undercoats; in which case these may be omitted, provided that the Consultant's/Client approval in writing is obtained beforehand.

All insulated or un-insulated pipework in concealed positions shall be identified by means of 75 mm wide identification bands, painted neatly on, at right angles to the pipe axis at intervals not greater than 3 meters.
In addition the name of the service and pipe diameter shall be stenciled on in a visible position with an arrow indicating the direction of flow. Flow and returns shall have the letter “F” or “R” added to the identifying name. The identifying band colours and the finishing colour of the services to be painted shall be agreed with the Consultant/Client prior to application, but for tendering purposes shall be in accordance with the colours and procedures given in ASH RAE Guides.

<table>
<thead>
<tr>
<th>Conditioned Air Supply</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned Air Return</td>
<td>Purple</td>
</tr>
<tr>
<td>Fresh Air</td>
<td>Green</td>
</tr>
<tr>
<td>Toilet Exhaust</td>
<td>Brown</td>
</tr>
<tr>
<td>Kitchen Exhaust, concealed,</td>
<td>Red</td>
</tr>
<tr>
<td>Condensate</td>
<td>White</td>
</tr>
</tbody>
</table>

Ductwork shall be identified in accordance with the procedures laid down in SMACNA.

All equipment located in concealed positions shall have a nameplate secured to the item giving the following information:

- Equipment reference number (as indicated on the record drawings.)
- System.
- Room/ Area served.
- Duty/ output information.

The nameplate shall be 100 x 100 mm approximately, of white plastic 3 mm thick with the above information engraved in black lettering and the plate shall be secured by screws, bolts, clips, etc., as appropriate to the item concerned.

This plate is in addition to any nameplate supplied by the manufacturer of the item giving detailed specification information for the equipment.

3.1.22 FLUSHING AND CLEANING.

Flush all fluid-carrying systems after completion as specified elsewhere. Discharge the flushing fluid through all strainers and out through line sized valves with hose ends. Clean all strainers. Repeat flushing operation to the approval of the Consultant/Client until the water is running clear, colorless and odourless.

3.1.23 INSPECTION, TESTING AND ADJUSTING.

All the works provided as part of this Contract shall be commissioned in accordance with all relevant Specifications and Codes of Practice (ASH RAE / CIBSE) and to the entire satisfaction of the Consultant/Client.

The Contractor shall employ the services of a specialist company approved by the Engineer regularly engaged in providing a testing balancing and commissioning service.

Carry out all tests specified. Carry out all tests required by Authorities having jurisdiction. Test equipment to the requirements of, and where necessary, in the presence of the Manufacturer.

Provide all equipment, labour, and instruments, loading devices, incidentals, and pay for all fuel, power and sundries required to carry out the tests.

All installations shall be inspected and tested in sections as the work proceeds and on completion as composite systems and it shall be noted that the Consultant/Client or any of the other relevant Authorities may require inspecting or testing any equipment during manufacture at the Manufacturer's works. All necessary arrangements shall be made as part of this Contract.

All tests shall be arranged in cooperation with the Consultant/Client and his Engineer and all other concerned parties and shall subject to time, location and nature of the test to be performed. No test shall be considered valid unless the Consultant/Client is present.
All necessary skilled and unskilled labour shall be provided for attendance during the tests (including pre- and post-test activities,) and the test media shall be provided and subsequently disposed of except where specifically stated otherwise.

The testing and adjusting is the contractual responsibility of the Contractor but actual performance of the tests is expected to be the sole responsibility of the Specialist Company.

Have all testing and balancing performed by only persons who are thoroughly versed in this type of testing and balancing and with proven ability. Submit names, complete with experience records, and references for approval of the Consultant/Client.

Any defects occurring at any time during the test duration shall be made good and a complete re-test shall be carried out, all at no cost to the Contract.

Where failure occurs during a test, inspection or commissioning procedure which results in damage to the building fabric and/or any services not provided as part of this Contract, or requires subsequent builder's work to be carried out, carry out all such repair work to the entire satisfaction of the Consultant/Client at no cost to Consultant /Client.

All test points shall be provided which are necessary to carry out the specified tests and commissioning procedures including facilities for measuring or monitoring temperature, pressure, pressure drop, volume flow, in-duct sound power or sound pressure, humidity, or other relevant conditions in both air side and water side systems. Such points shall be fitted with removable plugs, flanges, or other appropriate and approved devices.

Prepare test report forms for each test to be performed and submit these to the Consultant/Client at least two weeks prior to the commencement of any tests.

Test only after the system installation has been completed and the system has been put into continuous operation. Perform the testing, adjusting, and balancing when outside conditions are commensurate with the design conditions for the given system. Add dummy loads to the system if outside and inside conditions are less severe than the specified points.

Duplicate signed test certificates shall be provided after each test, which will be countersigned by the Consultant/Client who witnesses the test for further submission to Client. The test certificate shall give the following particulars: -

- Apparatus or section under test.
- Maker's number (if any).
- Nature, duration and conditions of test.
- Result of test.

No test shall be valid until the test certificate is provided.

Duplicate copies of test certificates carried out at Manufacture's works shall be forwarded to the Consultant/Client for approval prior to dispatch of the article to site.

No section of the works shall be insulated or in any other way concealed prior to testing and inspection and subsequent concealment where applicable shall only take place following written authority from the Consultant/Client.

All necessary facilities, measuring and recording instruments including test pumps and gauges for inspection, testing and commissioning requirements shall be provided and shall be checked or calibrated as necessary before use.

The Consultant/Client reserves the right to call for a demonstration of the accuracy of any instruments provided.

All representatives present during inspection, testing and commissioning shall be fully conversant with the system concerned and the method of system and instrument operation.
Manufacturers’ or Specialist Subcontractors’ representatives shall attend where specifically indicated elsewhere in the specification or where necessary to ensure full service and cooperation is available to the Consultant/Client to enable the works to be tested and commissioned in accordance with the requirements of the specification.

All necessary precautions shall be taken to safeguard against damage during inspection, testing or commissioning. Any damage so caused shall be made good at no cost to the contract.

All tests shall last for the minimum time period stated or longer if necessary to ensure all sections have been fully examined as required by the test.

3.1.24 INSPECTION OF THE WORK.

The representatives of the Client and the Consultant will make periodic visits to the site during construction to ascertain that the work is being executed in reasonable conformity with all plans and specifications, but will not execute quality control at all times. Contractor must maintain site order book and quality control as intended in the contract documents.

Correct all deficiencies immediately as noted during field inspections.

Request in writing that a final inspection of all services.

Do not issue this written request until:

All deficiencies noted during job inspections have been corrected.

All systems have been balanced and tested and are ready for operation.

All balancing reports have been submitted and reviewed.

All instruction manuals have been submitted and reviewed.

The cleaning up is finished in all respects.

All spare parts and replacement parts specified have been provided and receipt of the same acknowledged.

3.1.25 TESTING & COMMISSIONING OF SERVICES.

All checks and tests as per the manufacturer’s drawing/manual, relevant code of installation and commissioning for various type of equipments shall be carried out by the contractor as part of installation work.

All piping systems shall be flushed, chemically cleaned and then filled with treated water, or appropriate fluid, vented as necessary, and brought to operating conditions and the flows then regulated to the design values.

All water circuits shall be balanced by means of the regulating valves provided and flow rates shall be determined on a temperature and pressure drop basis.

Flow through pumps shall be measured by relating the pressure drop across the pump to manufacturers test curves. A copy of the test curve indicating the final operating point shall be forwarded to the Consultant for further submission to Client.

All refrigerant systems shall be tested for leaks and vacuum shall be held for at least 24 hours before breaking with nitrogen gas and Vacuumed, purged and charged according to A.S.H.R.A.E. standard methods. All safety controls and interlocks will be tested as part of the commissioning procedures.

Flow through coils shall be adjusted to give the design temperature difference. In general water systems shall be balanced in accordance with the guidelines. Upon completion of balancing and testing operations for heating and cooling systems, temperature measurements shall be taken in all rooms and the readings tabulated in schedule form together with hourly ambient temperature readings taken over the measuring period. Two copies of the schedule shall be forwarded to the Consultant for submission to Client.
All ventilating systems shall be commissioned in accordance with the procedures recommended. Duplicate schedules of commissioning results shall be forwarded to the Consultant/Client and shall detail the recorded air volume and percentage deviation from design air volume, for each air input and extract terminal. Wet and dry bulb temperature measurements shall be taken in all rooms served by air supply systems and the results indicated on the schedule of commissioning results. Also ventilation fan shall be tested for the capacity, spray performance, static pressure of fans, power consumption, noise level and vibration isolation and result shall conform to the approved data furnished by the contractor.

These shall be recorded together with external ambient wet and dry bulb temperatures measured at hourly intervals over the measuring period.

Sound pressure levels (dBA) shall be measured in all rooms containing supply or extract terminals, all plant rooms, all rooms immediately adjacent to plant rooms and all rooms located above or below plant rooms. The Consultant/Client may at his discretion request a spectrum band analysis of sound pressure in any locations. All motors shall be meggared and a minimum IR value of 1 megon shall be obtained.

All automatic controls shall be commissioned by the controls supplier.

Fault conditions shall be simulated and all alarms and safety devices shall function correctly. Such proving tests shall be carried out in the presence of the Consultant/Client and certificates shall be provided specifically detailing all check procedures, which have been carried out.

The consultant/Client may ask for additional tests on site that are necessary to determine the works compliance with the specification, manufacturer’s guarantee/instructions or the applicable code of installation. The contractor shall carry out such additional test also.

3.1.26 SYSTEM ACCEPTANCE.

The ultimate condition for system acceptance is that the Consultant/Client have inspected the system and found it to be acceptable, and indicated this in writing.

Submit original copies of letters from manufacturers of all systems indicating that their technical representatives have inspected and tested the respective systems and are satisfied with the methods of installation, connections and operation.

Submit, "As built" drawings and operation and maintenance manuals.

Train HAL maintenance staff.

3.1.27 CORRECTION AFTER COMPLETION.

Remedy all work in accordance with the General Conditions of Contract during the Maintenance period.

Attend immediately to any and all the defects occurring during the period defined above and repair in a manner to prevent recurrence. This contractor is responsible for all work required by other trades necessary to repair the works of this section, or necessary to repair damage caused by the failure of any part of this section.

Instruct all Suppliers and Manufacturers that guarantees on equipment will commence when the completed work is accepted and not from the date the equipment is put into operation. In the event that this condition is omitted by the supplier, or if subsequent cost to the Client is involved, in such cases Contractor shall be liable for bearing such costs.

3.1.28 GUARANTEES

The Contractor will guarantee all material and workmanship for at least 12 months after successfully commissioning and take over by the Client. During which period any or all components found to be defective shall be replaced or repaired free of cost and any short coming found in the system as specified shall be removed at no extra cost. The contractor shall provide the necessary personnel and tools for fulfilling the above guarantee. If the defects are not removed within a reasonable time the owner may arrange to rectify the same at contractor risk and without prejudice to any other right.
Guarantees will be full guarantees and will include all overhead, profit, incidental charges and sundries.

Where damage is caused to any other item by any failure of the item guaranteed, then the guarantee shall also include the costs incurred in rectifying that damage.

3.1.29 MAINTENANCE.

Maintenance is defined as the Contractual Liability to maintain the equipment in working condition, PLUS the regular checks and servicing of equipment during the maintenance period, including all the consumables and spare parts to keep the equipment in best working order.

Regular maintenance shall be as necessary, but in any event not less frequently than monthly. Breakdown calls shall be attended immediately.

3.1.30 SAMPLES

The contractor should submit two sets of samples of accessories or apparatus that are proposed to use for consultants/client for approval.

3.1.31 GENERAL TERMS AND CONDITIONS

(a) All tools and returnable items should be brought by the contractor within the premises of HAL on the contractor’s delivery challan. It will be contractor’s responsibility to take coordination from HAL security on the challan while bringing the items inside the premises of HAL. The contractor also required to preserve all the challan in separate files.

(b) The party /contractor may take his returnable material out of the HAL premises for repair or replacement or on permanent basis after completion of the work. Necessary Non-returnable gate pass will be issued by the concerned engineer-In charge of HAL on the basis of the material incoming delivery challan against which the material was brought inside the factory.

(c) The Contractor will be fully responsible for the quality of all material incorporated or brought for incorporation in the work.

(d) Contractor will be fully responsible for the safety of their personnel employed for execution of HVAC works.

(e) Contractor shall be fully responsible for the quality of all material incorporated or brought for incorporation in the work.

(f) The Contractor should follow all relevant codes and IS standards for HVAC equipments.

(g) For the material supplied like HVAC equipment, contractor should supply test certificates, from the OEM and conformance to tenders specifications.

(h) In case of minor items the contractor should offer the same for Pre dispatch Inspection. However the cost incurred on PDI in respect of the HAL team deputed for PDI shall be borne by HAL.

(i) The contractor should intimate in advance the readiness of the item for PDI along with following relevant details: a) Item to be inspected b) Place of Inspection. Subsequent on receipt of intimation of PDI, either the PDI will be carried out or based on the testing reports and standard document submitted before PDI, the same may be waived off. The decision of waive off PDI rests with HAL.

(j) The Delivery Challan of the supplied material with security clearance, test certificate & all the testing/commissioning report of the same should be persevered by the contractor in separate files. The same should be produced as and when required by the monitoring in charge during the execution of the work and finally submitted at the time of the project.

(k) The contractor has to co-ordinate with other division in advance for HVAC related civil & electrical works.

(l) A name board of the installation showing all details of the plant to be made and installed in the plant room by the contractor free of charges.

(m) The contractor shall also furnish all necessary consumables like anchor bolts and nut, crawl plugs, hosepipe blades, taps, dies, files, wire brushes, necessary pipe scaffolding, ladders, wooden and consumable material like oxygen, greases, nitrogen, fasteners, gasket, refrigerant gas, supports, cotton

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
(n) The contractor shall not dispose off transport or withdraw tools, tackles, equipment and material provided by him for the contract without taking prior written approval from consultant/Client. Consultant/Client at all times shall have right to refuse permission for disposal, transport or withdrawal of tools, tackles, equipment and material if in this opinion, the same will adversely affect the efficient and expeditious completion of the project.

(o) The contractor should furnish the details of all tools like welding & brazing equipments, testing equipments, test connection and kits etc, required for complete installation, testing and commissioning of the items included in the contract.

(p) The contractor should co-operate with other contractors at site in all matters of common interest through the consultant/Client/Engineer-in-charge, so that there should not be any obstruction to others and to ensure the safety of all personnel and works covered under this specification.

(q) The work should be carried out strictly as per the technical specification and execution drawing. In case of any doubt/misunderstanding as to correct interpretation of the drawing or specifications, necessary clarifications shall be obtained from consultant/Client. The contractor shall be made responsible for any damage to the equipment consequent to not following manufacturer's instructions correctly. All necessary drawing, manufacturer's manuals shall be furnished to Client and a copy to consultant.

(r) Any mishandling or loosening of equipments/component parts, after taken over by the contractor from client/manufacture till the complete installation/inspection shall be contractor responsibly only.

(s) The contractor shall out touch-up painting on any equipment indicated by the client/consultant, if the finish paint on the equipment soiled or marred during installation or handling.

(t) The contractor should verify the exact quantities of materials/equipments required after site measurements as per execution drawings by the engineer before procuring the same.

Please note excess quantities of material supplied without prior approval from Consultant/Client are at contractor risk and Client will not be responsible for taking back material.

3.1.32 HANDLING OVER AND TAKING OVER OF WORK/EQUIPMENT/SYSTEM

The contractor should hand over the works/equipments/system covered under this contract only after they have been completely installed, tested and commissioned in all respect by the Contractor to the entire satisfaction of the Client/Consultant and all relevant test forms/certificate operation and maintenance manual s as built drawing etc. should be forwarded to the consultant/Client. Any incomplete/partly commissioned works/equipments/system will not be taken over by the Client. In this regard, the decision of the consultant/Client will be final and binding on the contractor.

3.1.33 SAFE CUSTODY AND STORAGE

Safe custody of all equipment supplied by the Contractor shall be his own responsibility till the final taking over by the owner. He shall therefore, employ sufficient staff for watch and ward at his own expanse. The owner however, allows the contractor to use the plant room/weather maker room, etc for temporary storage of equipments if such space is ready and available.

3.1.34 REJECTION OF DEFECTIVE PLANT

If on test run or commissioning of any portion of the system, equipment or components are found to be defective or not fulfilling the intent or the meaning of specifications, the same shall be replaced or repaired to the entire satisfaction of Client.

In case the contractor fails to remove the defects, within a period considered reasonable, the owner reserve the right to take necessary remedial measures through other agencies and all expenses thus incurred would be recovered from Contractor.

3.1.35 Extra Item:

If any need arises for any additional item during the execution of work as per the site condition and not covered in the Bill of Quantities, the rate shall either be derived from the tenders items or substantiated by a rate analysis.
Scope of work under this package covers the manufacture, inspection, supply, installation, testing, balancing, commissioning, handing over, testing (including performance testing at contractors works and / or his subcontractors works), delivery to site, storing and handling at site, carrying out acceptance test, completion of validation procedures as Installation Quality, Assurance (IQA) and Installation Quality Control (IQC) standards at site for the entire HVAC system as per BOQ and as described in the tender technical specifications to the complete satisfaction of the client.

It is not the intent to specify completely herein, all the details of design and construction of the equipment and system. However, the equipment and system shall conform, in all respects, to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation in a manner acceptable to the Project Consultant / Client, who will interpret the meaning of drawings and specifications, and shall have the power to reject any work or materials, which, in his judgment, are not in full accordance therewith.

Quantities, sizes and capacities of various equipment/material mentioned in this specification and enclosed drawings are for contractor’s guidance only. Contractor shall carefully check the above-mentioned details while selecting and offering the equipment, System components complete.

The extent of supply under this contract includes all items shown in the bid drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification or schedules, notwithstanding the fact such items may have been omitted in the drawings. Also such of those items not specifically included in the specifications and drawings, but which are required to complete the intent of the contract shall also be deemed to be within the scope of supply of the Contractor.

Such other works which are not included in the aforesaid Bill Of Quantities are generally intended to be executed through a separate agency. Notwithstanding the above, the clients reserve the right to order additional works under the same contract. The clients also reserve right to omit any item of work included in the aforesaid Bill of Quantities and award the same to any other contractor or not perform it at all at their discretion and the Contractor shall not have any claim because of the same. This specification covers only the broad outline of the HVAC facility, Electrical and Mechanical system to be provided. It is the contractor’s responsibility to check and satisfy himself that the requirements / capacities of the equipment / system wherever indicated in this specification are adequate to meet the stated design. The contractor for this work shall be required to work in co-operation with other agencies on site and give them all reasonable assistance and help for execution of the work in an efficient manner.

3.1.37 RATES

The rates quoted by the Contractor shall include for supplying materials and labour necessary for completing the work in the best and most workman like manner to the satisfaction of the Engineer-in-Charge/Consultant and which in the option of the Engineer-in-Charge cannot be made better. The rates shall be complete in all respects and shall include cost of materials with all the taxes, erection, fabrication, labour, supervision, testing, commissioning, tools /tackles, transport, ALL sales and other taxes, royalties, ALL duties on material contingencies, breakage, wastage, sundries, scaffolding, initial training of the Client representatives etc. The total price shall be in INR and at the project job site. Contractor should indicate separately the custom duties, excise duties, for each of the items, wherever applicable.

3.1.38 GENERAL

The general character and the scope of work to be carried out under this contract are illustrated in Drawings, Specifications and Bill of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Project Consultant / Client.

3.1.39 ASSOCIATED WORKS

CIVIL & ELECTRICAL WORKS

Civil works like plant room, foundation of HVAC equipments, false ceiling with opening for grills and diffusers along with wooden frame work, wall opening for intakes, supply & return air duct, dampers, fire dampers, pipes and cables and then making good these opening by sealing them and finishing the same
ith P.O.P. HVAC contractor has to indicate in advance on civil contractor drawing before execution of works. Main incoming power cabling including earthing and termination to main panel of AHU, ventilation fan and split type A/c shall be done by electrical contractor. HVAC contractor has to indicate in advance on electrical contractor drawing before execution of works.

SECTION 2

WATER CHILLERS

1.0 SCOPE OF WORKS.

1.1 The works shall include design, manufacture, packing, forwarding, supply, installation, testing, commissioning, balancing, adjustment and setting to work of the Liquid Chillers as per the performance characteristics mentioned in this document at the site.

1.2 Manufacturer / Contractor is to assume full responsibility for the correct functioning of the Chillers / system and to carry any liability or other insurance or guarantee as may be necessary to protect all parties in this regard.

1.3 Manufacturer shall produce the relevant QA/QC certificates, factory run test reports, and certificate of origin at the time of delivery.

1.4 Manufacturer shall supply the chiller with all the associated items & accessories required shall be supplied delivered and installed.

1.5 Packing & forwarding of the Chillers shall be as applicable standard skid mounted or factory standard with necessary wooden frames, packing covers and other safety standards as applicable for shipping activities from the country of origin to the site. If it is observed during the physical inspection that the Chillers delivered are not meeting the performance ratings and technical standards/specifications of the tender, then the manufacturer/vendor at his own cost shall replace the same with the correct equipment. If it is observed during the physical inspection that the Chillers delivered are damaged, then the manufacturer/vendor at his own cost shall replace or make good the damages and ensure client satisfaction.

1.6 The Loading, unloading, shifting and installing of the Chillers at the designated place is the scope of the Supplier & Contractor.

1.7 Testing (factory and field), start-up supervision, training and providing necessary documentations and tools for operation

1.8 Carry out performance test run at site

2.0 DESIGN PARAMETERS

Design, in general, shall be based on ASH RAE/ARI recommendation with the following particular requirements:

2.1 DESIGN TEMPERATURE CONDITIONS

<table>
<thead>
<tr>
<th>SITE</th>
<th>NASIK.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) AMBIENT CONDITIONS</td>
<td>SUMMER</td>
</tr>
<tr>
<td>b) Performance Base</td>
<td>NASIK - Elevation level conditions.</td>
</tr>
</tbody>
</table>

2.2 NOISE LEVELS

Noise level of the Air cooled Chiller machines shall be strictly in accordance with the Standards and ratings mentioned in the ASH RAE / ARI. Any deviation from the acceptable range will need a
2.4 DESIGN CRITERIA

2.4.1 Chilled Water:

Chilled water inlet temperature : 54 ºF
Chilled water outlet temperature : 44 ºF
Condenser water inlet temperature : 88 ºF
Condenser water outlet temperature : 96 ºF

Maximum velocity of water through pipework: 7 fps

Pipes to be sized for full flow rate of all cooling coils.

2.5 General:

Chiller Unit to be in accordance with the ARI 550/590 USA and should be IKW/TR as per ASHRAE 90.1.

Construction shall comply with ASHRAE 15 Safety codes, UL 1995, ETL, NEMA, ASTM 653 and ASME codes of USA.

The manufacturing facility shall be an ISO 9001:2000 certified with respect to manufacturing quality standards

Unit shall be full load run tested and all necessary certificates and reports for the same to be produced prior to delivery for approval of the concerned.

The compressor motors conform to NEMA standards, MG-1 & MG-2.

10 WATER COOLED PACKAGED LIQUID CHILLERS – SCREW TYPE

SCOPE

3.10 The Screw water chilling units shall be factory assembled and tested complete in all respects and shall be complying with all relevant ASHRAE standards.

3.11 Manufacture and supply of screw chiller with associated motor, soft starter and accessories.

3.12 All associated items herein to be supplied delivered and installed.

3.13 Assembly of chiller components including connection of cooler, condenser, motor, compressor etc into complete refrigeration machine at factory.

3.14 Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.

3.15 Provide manufacturers factory representatives services, including coordination and start-up and testing supervision.

3.16 Carryout performance test run at site.

3.17 The Test Certificates shall be submitted along with the Machine.

3.18 Tests shall be carried out for all parameters as per ARI Standards at the Factory. Performance test at site are also mandatory.

3.19 All the selection ratings shall be submitted along with the Offer.

31 WATER CHILLING UNIT

The Machine shall be factory assembled, single-piece chassis, Water-cooled liquid chiller with microprocessor controller. Contained within a single cabinet the unit shall be with complete factory wiring.
The Machine shall have equal rating Compressors on it and shall be a single piece assembly complying with and comprising of the following:

(a) Unit to be rated in accordance with ARI 550/590-98 USA standards
(b) Minimum Two Semi Hermetic Screw type compressors with motor and speed increasing gear assembly.
(c) Unit construction shall comply with ASHRAE 15 Safety Code, NEC, and ASME applicable codes (U.S.A. codes).
(d) Unit shall be manufactured in an ISO 9001-2000 registered facility.
(e) Shell and Tube Condenser with accessories.
(f) Direct expansion/Flooded Shell and Tube Chiller with accessories.
(g) Steel structure for assembling/mounting the above.
(h) Control panel with automatic capacity control device and various safety gauges and devices.
(i) Inter connected refrigerant piping with all accessories.
(j) Full first charge of refrigerant R-134A gas & oil.
(k) Starter for motor with inrush current not exceeding 1.8 to 2 times operating current.
(l) Insulation of Shell and Tube Chiller with 32 mm thick nitrile rubber or equivalent material or Polypropylene.
(m) Microprocessor panel with all safety interlocks and communication ports.
(n) Unit mounted flow switches with necessary interlocks.
(o) The chiller should have very low power consumption at full load as well as part load condition
(p) Chiller should be

3.2 COMPRESSOR

The Twin Screw type compressor shall be Semi hermetic in design with facility to field service in case of any maintenance. The compressor should have highly efficient and low noise levels. The compressor motor shall be direct drive, 3500 rpm, protected by motor temperature sensors and shall be suction gas cooled. The screw shall be horizontal / vertical design with a set of gears with unequal number of lobes for high compression. The rotor shall be of either 2/3 gears, which are statically and dynamically balanced reducing vibrations, increase life of equipment. The rotors shall be made of high strength alloy steel material to withstand high pressures and temperatures. They shall be machined to close tolerances for high efficiency and low energy consumption. The rotor should be designed to withstand liquid slugging in case of eventualty. The screw rotors shall be mounted on class 5 grade roller Element bearings and should be able to withstand thrust loads and dynamic loads on the gears. Each compressor should be designed to operate up to a capacity of 25% of its total output in step less or defined steps as is suitable. These compressors should also be provided with integral internal economizers where centrifugal force will separate the flash gas from liquid refrigerant entering into the evaporator. The compressor connection shall be provided with isolating refrigerant valves to ensure compressor removal without system pump down. The external oil separator to be provided to effectively separate oil from the refrigerant. The oil automatically returns back to the compressor through an oil level float valve. Each compressor shall be equipped with suction and discharge valves, internal muffler and check valves. The compressor housing shall be of high-grade cast iron, machined with precision to provide a very close tolerance to the rotor(s) and the housing. The compressor shall be interlocked with the differential pressure switch in the chilled line, differential pressure switch in the condenser line, anti-freeze therostate, condenser water pump, chilled water pump. The interlocks shall be provided with indicating lamps in the control panel in the refrigerant plant room.

CAPACITY CONTROL

The capacity control shall be carried out by the microprocessor panel with operation levels of minimum 15% to 100% of full load, in conjunction with a slider valve mechanism. The power consumption of this compressor should not be more than 0.75 KW/TR of refrigeration at all operating conditions. In case of multi-compressor lead/lag compressor shall be advocated. It shall require the system in order to operate the equipment at optimum operation at maximum energy efficiency range. It shall operate the lead compressor and shall allow the lag compressor to operate on demand increase being more than 75% of lead compressor allowing lead and lag compressors to operate at part loads for high energy efficient
3.3 MOTOR

The motor shall be of refrigerant cooled type squirrel cage induction type motor class F insulation suitable for operation at 415 V/3 PH / 50 Hz supply with motor able to withstand voltage fluctuation of 415V ± 15% - 15% and it should be energy efficient. The motor shall be refrigerant cooled with independent isolation of circuit in case of any maintenance to attend on motor within the hermetic casing. The motor/compressor assembly shall be statically and dynamically balanced for reducing vibration and noise. The motor shall be protected thermally and current as well. IKW/TR shall not exceed 0.71.

3.4 STARTER FOR COMPRESSOR MOTOR

The starter provided on the unit shall be such that it will ensure starting current not to exceed 2.0-2.5 times the rated current. It shall also include all necessary safety devices i.e., overload relays, under voltage release, single phase preventing device and phase unbalance or reversal. They shall be provided with over current and under current protection.

3.5 CONDENSER:

Water-cooled design to be tested in accordance with ASME codes for refrigerant working pressures of 1410 KPA, water side pressure rating shall be 2070 KPA. The unit shall be of horizontal shell and tube type mechanically cleanable water-cooled type multi-pass condenser. Design shall incorporate complete independent refrigerant circuits based on the number of compressors. It shall be either 1 pass or 3 pass type. The shell shall be of carbon steel plate with fusion welded seam it shall be fitted with machined steel tube sheets on either end. The condenser tube shall be at least 12 mm OD and 1 mm thick seamless copper with integral fins. The tubes shall be supported in the shell by baffle supporting plates to achieve minimum vibration and its ends shall be properly expanded in the tube sheets to prevent leakage of refrigerant. The condenser shall be provided with removal heads on either side made of cast iron or steel with neatly machined surface for effective jointing with the shell for accessibility for cleaning/replacement of tubes. Suitable baffles shall be incorporated to achieve the required number of passes. It shall be possible to descale the tubes without disconnecting the water line connections. In case of multi compressor machine the condenser shall have two independent circuits for ease in operation and circuit isolation. Fouling factor for Condenser - 0.00025 hr.sft.F/Btu. The condensers shall have water boxes designed for unit pass flow. Tube may be provided with special tabulating arrangement to improve heat transfer.

The condenser shall be complete with the following accessories.

a. Support for mounting
b. Inlet and outlet connections of the Refrigerant.
c. Flanged Water in & out connection
d. Shut off and adjusting valve, auto air vent, test cocks (if any),, relief valve and purge valve.
e. Drain cocks and air vents
f. Dial type temperature gauge / pressure gauge to be provided at water inlet and outlet.
g. It should be fitted with a safety relief valve, lique de shut of valves and a purge vale.

3.6 REFRIGERANT COMPONENTS

Refrigerant circuit components shall include Oil separator, high and low side pressure relief valves, discharge and liquid line shut off valve, filter drier, sight glass, Electronic expansion valves, economizers & complete charge of R134a gas & oil with compatible and manufacturer recommended oil.

3.7 CHILLER – COOLER (EVAPORATOR)

The Chiller unit shall be direct expansion shell and tube construction. The shell shall be of carbon welded steel plate construction filled with machined steel tube sheets on either of the end. The evaporator shall have highly efficient integrally seamless hard drawn finned copper tubes of not less than 12 mm OD and 0.7 mm thickness. The tube shall be supported in the shell with suitable stiff support to achieve minimize vibration and noise level. The tube ends shall be mechanically bonded to the tube sheets to prevent leakage of refrigerant. The evaporator shall be provided with eliminator to prevent liquid carry over to the compressor. In case of multi compressor machine, the chiller shall have two independent circuits for ease in operation and circuit isolation. The evaporator shall be insulated with 32 / 50 mm thick insulation PVC

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex)

VOLUME –II. TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

oam (or closed-cell nitrile rubber) with a maximum K factor of 0.28. The evaporator shall be provided with liquid level sight glass and pressure relief device to prevent excess pressure in the heat exchanger. The evaporator shall be hydraulically tested with a pressure of 300PSIG on the shell and waterside. Fouling factor for Condenser - 0.0001 hr.sft.F/Btu. The evaporator shall be complete in all respect and provided with following accessories.

- Refrigerant inlet and outlet pressure gauges.
- Refrigerant inlet / outlet Flange connection.
- Water in/out flange connection with thermometer.
- Drain & vent connection with stop valves.
- Pressure gauges on water inlet and outlet connection
- Decaling valves.
- Flow switches in water line.
- Liquid line solenoid valve as required.

3.8 ELECTRICAL / CONTROL PANEL

The control panel design to be equivalent to NEMA 4 (IP55) with hinged door for easy access ensuring dust, Vermin and weatherproof construction and suitable for operation in plant room Conditions without malfunctioning or damage of any type. Internal power and control wiring to be neatly routed, adequately anchored and all wires identified with cable markers as per NEC standards applicable to HVAC units.

The electrical controls used in the control panel to be UL approved with care reliable in operation at high ambient conditions for a long period.

The components of both the power and control shall be split into two sections of main panel accessed by individual key locked doors. The panel shall be manufactured to ensure protection in all weather conditions. The power panel shall be fitted with door interlocked mains isolator to prevent access while it is live. The power section shall include all the necessary contactor fuses for compressors. The control center shall house all the electrical safety features for system safety.

Electrical Requirements:
1. Unit primary electrical power supply shall enter the unit at a single location. Include separate the terminal blocks for the power and controls. Include necessary disconnect and isolator.
2. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
3. Control voltage shall be 115-v (60 Hz) or 230-v (50 Hz), single-phase, separate power supply.
4. Unit shall be shipped with factory control and power wiring installed.

3.9 ELECTRONIC EXPANSION VALVE (EEV)

The unit shall be provided with electronic expansion valve one for each circuit/compressor which works on electronic signal on system requirement and operate accordingly for precise control of refrigerant flow through the cooler and accurately maintain the desired liquid level. The electronic expansion valves shall act by themselves as liquid line solenoid stop valves along with expansion valve for proper shut down. All the valves for multi-compressors shall be interfaced with the microprocessor control system for optimum system utilization and operation. The electronic expansion valves should maximize operating efficiencies on part and full load operations. During part load operations, the EEV's combined with microprocessor panel should provide stable operating conditions and maximize energy saving potential, using logic.

3.10 MICRO PROCESSOR CONTROL PANEL

A microprocessor based control panel shall be fully wired, tested and factory mounted on the chiller. This shall be a part of the factory assembled chiller which shall be installed in a separate vermin proof panel and unit mounted in a locked enclosure. It shall have non-volatile memory. The panel shall have a soft touch keypad which can be used for setting/altering illustrating the machines operating status, programmable parameters, temperatures and pressure of fluids, it shall have intelligent software for predictive logic to select the most energy efficient combination of compressor/cylinder and electronic expansion valves to maintain stable operating conditions and maximize energy efficiency. The panel should also have the feature of rotating the multiprocessors for equal hours. The microprocessor shall also have diagnostic memory of latest fault conditions together with record of when they occurred. It shall have a record of last six faults occurred. It should also have internal clock to programme the operating schedule of the chiller in order to meet specific building load profile precisely. The Microprocessor panel shall have a voltage stabilizer to take care of +5% to -15% variation in control supply voltage. It shall also have the record of

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 339 of 494
energy consumed every hour. The panel shall also have facility to, communicate with Computer Control center within the plant room by providing necessary interface port on each panel at a future date. It shall have minimum 3 level password protection for operation system and changing of set points. All machines shall be provided with record of energy consumed and capacity delivered as a part of the system microprocessor.

3.11 REFRIGERANT PIPING

The refrigerant piping interconnecting all the above equipment shall be Heavy duty Seamless copper with tube dia as required and having a wall thickness of minimum 2 mm and able to withstand pressure upto 500 PSI. Necessary gas mufflers, flexible connections on discharge and suction side shall be provided to reduce vibration/noise of refrigerant/compressor.

3.12 Controls, Safeties, and Diagnostics:

1. Controls:
   a. Unit controls shall include the following minimum components:
      1) Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
      2) Power and control circuit terminal blocks.
      3) ON/OFF control switch.
      4) Replaceable solid-state relay panels.
      5) Pressure sensors for suction/discharge, oil, economizer pressures. Thermistor installed to measure saturated condensing temperature, cooler saturation temperature, compressor return gas temperature, and cooler/condenser entering and leaving fluid temperatures.
      6) Chilled / condenser fluid flow switch.
   
b. Unit controls shall include the following functions as standard:
      1) Automatic circuit lead/lag
      2) Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1 ° F (0.06°C).
      3) Limiting the chilled fluid temperature pull-down rate at start-up to an adjustable range of 0.2°F to 2°F (0.1°C to 1.1°C) per minute to prevent excessive demand spikes at start-up.
      4) Seven-day time schedule.
      5) Leaving chilled fluid temperature reset from return fluid, outdoor-air temperature, space temperature, or 4 to 20 mA input.
      6) Demand limit control with 2-stage control (0 to 100% each) or through 4 to 20 mA input (0 to 100%).
      7) Chilled water pump start/stop control.
      8) Dual chiller control for parallel flow applications use one additional sensor.
      9) Amperage readout per compressor with %MTA per compressor.

c. The control panel shall include, as standard, a portable hand held display module with a minimum of 4 lines and 20 characters per line, of clear English language. Display menus shall provide clear language descriptions of all menu items, operating modes, configuration points and alarm diagnostics. Reference to factory codes shall not be accepted. An industrial grade coiled extension cord shall allow the display module to be moved around the chiller. Magnets shall hold the display module to any sheet metal panel to allow hands-free operation. Display module shall have NEMA 4x housing suitable for use in outdoor environments. Display shall have backlight and contrast adjustment for easy viewing in bright sunlight or night conditions. The display module shall have raised surface buttons with positive tactile response.

d. The chiller controller shall include multiple connection ports for communicating with the local equipment network and the ability to access all chiller control functions from any point on the chiller.

e. The control system shall allow software upgrade without the need for new hardware modules.

2. Safeties:

Unit shall be equipped with thermostats and all necessary components in conjunction with the control system to provide the unit with the following protections:

a. Loss of refrigerant charge.
b. Reverse rotation.
c. Low chilled fluid temperature.
d. Low oil pressure (each compressor circuit).
e. Voltage imbalance.
f. Ground current fault.
g. Thermal overload.
Diagnostics:

a. The control panel shall include, as standard, a display:
   1) Touch screen display consisting of 1/4 VGA LCD (liquid crystal display) with adjustable contrast and backlighting.
   2) Display shall allow a user to navigate through menus, select desired options and modify data.
   3) Information included for display shall be a minimum of 12 parameters

b. Features of the display shall include:
   1) Display shall be customizable and allow up to 72 data points.
   2) Display shall support both local equipment or network made for remote mount.
   3) Display shall allow access to configuration, maintenance, service, set point, time schedules, alarm history and status data.
   4) Display shall have one button for chiller on/off.
   5) Display shall include three levels of password protection against unauthorized access to configuration and maintenance information, and display set up parameters.
   6) Display shall allow for easy connection of a portable hand held technician tool to access information and upload and/or download chiller settings.
   7) Display alarms and parameters shall be capable of being displayed in full text.
   8) Display shall be capable of displaying the last 50 alarms and will store a snapshot of a minimum of 20 status data parameters for each alarm.

10) Compressor run hours.
11) Compressor number of starts.
12) Compressor current.
13) Time of day:
   a) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
   b) Diagnostics shall include the ability to review a list of the 30 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
   c) An alarm history buffer shall allow the user to store no less than 30 alarm events with clear language descriptions, time and date stamp event entry.
   d) The chiller controller shall include multiple connection ports for communicating with the local equipment network system and the ability to access all chiller control functions from any point on the chiller.
   e) The control system shall allow software upgrade without the need for new hardware modules.

14) The unit shall display entering & leaving chilled water temperature, entering & leaving condenser temperature, evaporator, suction, discharge, condenser water temperature, LP, HP & OP display, Motor amperes and amps as a percentage of rated load amps, hour of operational number of starts, time of last start & stop, chilled water set point and rest temperature set point.

The display module shall be capable of indicating the safety lockout condition by displaying the information in clear language at the display. Information included for display shall be:

1) Compressor lockout.
2) Loss of charge.
3) Low fluid flow.
5) Cooler freeze protection.
6) High or low suction superheat.
7) Thermistor malfunction.
8) Entering and leaving-fluid temperature.
9) Evaporator and condenser pressure.
10) Electronic expansion valve positions.
11) All set points.
12) Time of day.

3.13 STEEL STRUCTURES

The total unit shall be assembled on formed steel sections heavily galvanized, (G-90) galvanized steel. The MS supporting frame shall be sturdy and heavy gauge construction to withstand physical and dynamic loads during Chiller operation. The quality conforming to ASTM codes and standards. Frame Design shall permit easy removal and maintenance of various components. The cabinet / frame shall be sturdy enough to withstand transport without getting distorted and when stationary handle the equipment load.

The compressor shall be mounted on structural frame with vibration isolation springs ensuring the compressor vibration not transferring into the steel structure. The units shall be mounted on vibration isolation spring with maximum deflection of spring not exceeding 5mm under operation. There should be proper encasing of unit from all sides to reduce noise levels of the equipment.

3.14 ACCESSORIES

In addition to the above each unit shall include the flowing.
(a) Water flow switches at the inlet/ outlet of evaporator.
(b) Spring isolation pad of not less than 80% efficiency.
(c) Full charge of refrigerant gas and required quantity of lubrication oil.
(d) Temperature / Pressure gauge at inlet/outlet of the condenser and the evaporator complete with isolating gate valve.
(e) Valves for cleaning of condenser drain water and purging of air.
(f) The each unit shall be factory painted with minimum two coats of synthetic enamel paint.
(g) Chillers shall have a Field-installed sequencing Kit control to sequence between 2 and 8 chillers in parallel in a single system.

Over and above whether specifically mentioned in the schedule of equipment or not but are required to be provided to form a complete system, found necessary to fulfill the intent and meaning of the system requirements shall be provided without any extra cost implication.

3.15 PERFORMANCE

The complete water-chilling unit shall be mounted on RCC foundation using grouting bolts, nuts, channels, etc. On installation the refrigeration circuits and the connected equipments & parts shall be thoroughly tested leakage.

The unit shall be selected for the lowest operating noise level capacity rating and power consumption with operating point clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. Capacity shall be ascertained by measurement of chilled water flow rate and temperature of chilled water in and out of the chilling unit.

The performance of the unit shall be proved at site at the time of installation and also the power consumption should not exceed the confirmed rating through out the period of service of the equipment. The company shall stand guarantee for the aforesaid condition and shall compensate the client in case the power consumption proved at site is more than the stipulated power. The rate of compensation shall be as indicated in penalty clause of the conditions of contract. The contractor shall submit along the tender the computer selection rating charts of the machines offered. This shall indicate the selection of model of Compressor, Condenser, Chiller along with it full load rating of capacity and Power consumption. The selection shall also indicate IPLV/NPLV values along with part load performance with ARI relief and also constant condenser water temperature inlet. The selection chart shall provide details of percentage
capacity, power consumed, rated amperage, locked rotor amps and also inrush currents of equipment at maximum ambient conditions.

(d) Testing

The unit shall be tested for establishing the capacity and power consumption.

Test shall be carried out on:

(c) The compressor drive motor side
(d) Condenser Side
(e) Chiller side

All meters, gauges, thermostaters, wattmeters shall be duly calibrated standard type and all necessary distance pieces, etc. required in the piping for insertion shall be provided at the time the piping is installed. All test reading shall be co-related with each other and the design parameters before submission for approval. At least four reading lasting over a period of three hours shall be recorded.

Note: Water chilling plant shall be inspected at the manufacturing site before dispatch.

3.17 Painting

Screw chilling machine shall be finished with durable enamel paint. Shop coats of paint that have become marred during shipment or erection, shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

21.9 SUBMISSIONS.

4.1 Complete selection sheets indicating the technical performance characteristics of the selected chillers. Supporting engineering catalogs with full technical details are to be submitted for approval. The vendor to confirm the compliance with proposed capacities without any dilution in the performance selection criteria at the bidding stage itself.

4.2 After final checking of sizing after award of contract, resubmission will be made with any changes specifically noted. The final submittal shall include the GA drawings, installation and execuation data.

.1 In the event that the Consultant/client requires further information on any of the proposed items the Contractor shall arrange visits to similar units, which he has installed. In any event, all equipment proposed for the project shall be currently installed and working satisfactorily locally. The Contractor must be able to provide references of at least three satisfied Owners and Consultant with equipment of the particular size and model proposed.

SECTION 3

WATER PUMPS & COOLING TOWERS

Scope of Work

Supply, Installation, testing, balancing and Commissioning of pumpset with motor and all the associated accessories for condenser and chilled water pumping conforming to these specifications and in accordance with requirements of schedule of quantities.

SYSTEM DESCRIPTION

Furnish and install a factory assembled Constant speed packaged pumping system equal to ITT BELL & GOSSETTE/GRUNFOS/ARMSTRONG/KIRLOSKAR/BEACONS Chilled & condenser Water pump. The
SUBMITTALS

A. Submit shop drawings and product data; the following information shall be minimum:
1. System design information sheet.
2. Description of system operation.
3. Packaged system dimension and general arrangement drawing.
4. Pump material and construction drawing.
5. Pump curve showing design point.
7. Catalog information on valves, strainers and control components.
8. Electrical power and control-wiring diagram.
9. Catalog data on Direct Digital Controller.

B. Submit manufacturer's installation instruction.

OPERATION AND MAINTENANCE DATA

Submit operation and maintenance data. The following information shall be minimum:

1. System design information sheet.
2. Description of system operation.
3. Packaged system dimension and general arrangement drawing.
4. Electrical power and control wiring diagram.
5. Bill of material.
6. Pump operation and maintenance instructions.
7. Special electrical component operation instructions.

QUALITY ASSURANCE

A. The manufacturer of the chilled water pump and control package must be listed by Underwriters Laboratories as an approved manufacturer of UL “Packaged Pumping Systems” and as a manufacturer of industrial control panels under UL Section 508. The manufacturer shall furnish proof of the two listings as part of the submittal data.

B. The packaged pumping system manufacturer shall provide published catalog data clearly indicating that HVAC Packaged Pumping Systems are one of their standard product lines.

C. The manufacturer of the packaged pumping system shall have in place an ISO 9001 compliant Quality Assurance Program to assure the quality of engineering design, components, materials and workmanship provided in the packaged pumping system. Upon request, this procedure shall be submitted to the engineer.

D. The manufacturer shall have a minimum of ten years manufacturing and application experience and shall be responsible for the proper pressure and flow in the entire packaged system.

DELIVERY, STORAGE, AND HANDLING

Safe delivery, storage and handling of the products shall be in line with the recommended practice of the manufacturer.

A. General:

The packaged system shall consist of a system base, pumps, motors, valves, intermediate piping, piping supports, controls and other components as listed in this specification for a complete system. Each pump shall be provided with a coupling guard, air vent cocks, suction and discharge gate valves, discharge non return valve and a pot strainer. The Secondary chilled water system shall be designed for a total system flow as indicated in the schedules and BOQ.
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex)

Volume II. Technical Specifications for Tender No. NKFW/CAP-R01577/2010-11

Page 345 of 494

Pumps shall be End Suction Back pull out type unless indicated specifically. Pump set shall be factory aligned and installed on suitable concrete foundation block with vibration isolation mounts.

B. Components

All components shall be mounted on a structural steel base. The base shall be large enough to support the packaged pumping system's pumps, piping and control panel(s). Steel supports shall be welded to the base to support the piping and control panel(s). Both the base and supports shall consist of structural steel components, all welded per the AISC Manual of Steel Construction, part 4 “Welded Joints”. The base depth shall be equal to 1/12 the longest span between spring isolators but not greater than 12”. Minimum depth shall be 6”. The mass of the base shall provide adequate natural inertia to eliminate the need for field poured concrete. Provide vibration isolation in form of inertia base, reflected in typical details drawings and meeting local codes and requirements.

Casing

Pumps shall have the casing divided either on the horizontal or vertical centerline. The casing halves shall be accurately machined bolted together. A non-asbestos type gasket material shall be furnished between the casing halves. The casing material shall be close grained cast iron with a minimum tensile strength of 2300 kg/cm². Removal of the upper casing half shall permit removal of the complete rotating assembly without disturbing piping connections.

Casings shall be designed for scheduled working pressure and shall be hydrostatically tested. Suction and discharge flanges shall be drilled to ANSI Standards and be machined flat face.

Impeller

The bronze impeller shall be an enclosed type double suction design, hydraulically and dynamically balanced. The impeller is to be securely mounted on the stainless steel shaft, and attached with a stainless steel impeller key. The impeller shall be locked in position by threaded sleeves.

Bearings

The stainless steel pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to 0.05 mm.

Bearings shall be the ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads.

Shaft Seal

The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule.

Shaft / Sleeves

Shaft shall be suitable grade Stainless Steel. Bronze shaft sleeves shall be firmly attached to the pump shaft through threading and locking means. Shaft sleeve design shall prevent corrosion and wear to the shaft.

Base, Coupling and Guard

The pumps shall be mounted on a cast iron base and directly connected through a heavy duty flexible coupling to a horizontal motor. The base shall be provided with a drip rim. The pump manufacturer shall provide coupling guard, which shall be mounted between the pump and motor and attached firmly to the base.

Pump design shall be as indicated on the drawings, either frame mounted end suction or horizontal split case, flexible coupled, with cast iron casing, bronze impeller, shaft sleeve, stainless steel shaft, and mechanical seal(s). Each coupling shall include an approved coupling guard. Pumps shall be factory...
a. Balance rotating parts, statically and dynamically.
b. Construct to permit servicing without breaking piping or motor connections.
c. Operate at 415 V, 3 Ph and 50 Hz, 1450 rpm unless specified otherwise.

3. Motors shall be of the premium-efficiency EFF 2 type, TEFC with a 1.15 S.F. Motor manufacturer's stated efficiencies shall be derived from tests conducted in accordance with NEMA Standard MG1-12.53a which is based upon IEEE Standard 112, Method B.

The motor shall be sized to operate continuously without exceeding the horsepower rating regardless of the flow and head throughout the entire range of operation. Motors shall be TEFC, 1450 RPM. Motors shall be selected for the pumps to operate at any point of the pump curve.

4. The pump and motor design conditions shall be as described on the pump schedule. Pumps shall not overload the above motor sizes at any point on the pump curves.

5. Flexible connectors shall be furnished for the suction and discharge system connections. The connectors shall be constructed with steel flanges and a neoprene and nylon body. Connectors shall have a working pressure from 16" HG to 225 PSIG.

Design range shall be 0 to 100 FT water. External zero and span adjustments over-pressure to 2,000 PSI, and no humidity effects.

Minimum accuracy shall be ± 0.15% of calibrated span. Includes combined effects of linearity, hysteresis and repeatability. Stability shall be ± 0.25% of upper range limit for six months. No internal mechanical linkages shall be used in the transmitter(s).

FABRICATION

The packaged pumping system manufacturer shall provide a completely assembled and working water circulating system, fabricated using all new components. Fabrication shall incorporate sound engineering design, proven manufacturing techniques, and the latest proven technology available.

FINISHING

A. The manufacturer shall operate and maintain a paint spraying facility that conforms to EPA, OSHA and local codes requirements.

B. All steel components shall be cleaned, degreased and painted with a rust preventive, self-etching primer.

C. The complete packaged pumping system shall be factory painted with lead free, high gloss synthetic enamel prior to shipment.

D. Nameplates for each major component including pumps, motors, variable frequency drives, and electrical control panels shall be masked prior to painting and all shall be clean and clearly legible prior to shipment.

SOURCE QUALITY CONTROL

A. TESTING FACILITY

The packaged pumping system manufacturer shall maintain an operating test facility at the point of manufacture and shall perform test each component and feature of the assembled water circulating system with its remote transmitters and controls. The facility shall include components for measuring various features of the system, which are traceable to the National Bureau of Standards.
FACTORY TESTS

1. After factory assembly, the packaged pumping system shall be hydrostatically tested at 50 PSIG over maximum system working pressure or to 150 PSIG (whichever is higher) for a minimum of one hour.

C. INSPECTIONS

The manufacturer shall provide access to fabrication facilities to the owner or his representative at any time during the construction of the packaged pumping system. All testing may be witnessed by a representative of the owner, contractor and/or consulting engineer.

D. VERIFICATION OF PERFORMANCE

A written report certified by an officer of manufacturing company shall be provided to the owner’s representative on request.

COOLING TOWER

SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of cooling tower conforming to these specifications and in accordance with requirements of schedule of quantities.

The Cooling towers shall be meeting and rated in accordance with the international test standards CTI ATC 105 1990.

INDUCED DRAFT COOLING TOWER

To remove heat generated by the water chilling plant induced draft cooling towers are envisaged comprising of FRP casing. FRP water basin, Sprinkler section, Elimination, TEFC motors and induced draft axial fans.

Casing

The casing shall be of fiberglass reinforced plastic, which shall be non-corrosive, weather proof & light in weight. The casing shall be supported with galvanized iron structural for rigidity. Each cooling tower shall be in cylindrical/rectangular in form and shall be able to withstand wind velocities up to 50 KM PH.

Water Basin

The water basin shall be also of fiberglass reinforced plastic, which shall withstand high temperatures, with socket or flanged inlet/outlets/make up/overflow for piping connection. An auxiliary suction tank shall also be provided with piping flanges or sockets.

Sprinkler system

Automatic rotary sprinkler system with rotary head and standpipe should distribute the hot water over the entire surface of the in-fill. The sprinkler pipe shall be non-clogging and should require low pressure to operate and also to ensure uniform water flow with minimum operating pump head.

Eliminators

Proper eliminators should be provided for low pressure drop and drift losses of water.

Fans & Motor

The fan shall be of induced draft axial flow with adjustable pitch angles. The fan should be direct driven preferably of Aluminum alloy or FRP. The motor shall be of weatherproof TEFC construction and should be suitable for 41510%, 50 Hz, 3 Phase, AC supply.

PERFORMANCE DATA

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
The cooling tower performance and power consumption shall be submitted along with the tender and verified at the time of testing and commissioning of the cooling tower.

**DETAILED SPECIFICATIONS**

**GENERAL:**

(i) Design to withstand 1436 Pa wind load equivalent to 110 mph wind.

(ii) Free water drift loss shall not be greater than five hundredths of one percent of the water circulated to tower.

(iii) Sound levels at 50 ft in any direction shall not exceed 72 dbA – top, 66 dbA end CTI specified norms.

(iv) Manufacturer shall certify that performance of cooling towers will meet contract requirements, stating entering air wet bulb temperature, entering and leaving condenser water temperatures, water flow rates, fan kW (horsepower), and pump head at base of tower.

(v) Cooling Tower Institute (CTI) Certified Towers: These towers shall have been tested, rated, and certified in accordance with Cooling Tower Institute (CTI) Standard 201, and shall bear the CTI certification label, and shall be listed in the CTI directory of certified cooling towers.

(vi) Non-CTI certified Cooling towers: If CTI certification is not available, manufacturer for towers of 700 kW (200 tons) or larger, shall submit curves showing predicted performance as required in ASME PTC-23, or CTI Bulletin ATC-105 for Water Cooling Towers, and CTI Bulletin ATC-105S for Closed Circuit Cooling Towers.

(vii) Fan, motor alignment, balancing shall be in accordance with the CTI specified norms.

(viii) Cooling tower shall be supplied with ladder.

**Shop Drawings:**

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Include rated capacities, pressure drop, fan performance and rating curves, dimensions, weights, mounting details, front view, side view, equipment and device arrangement.

3. Include electrical rating, detail wiring for power, signals and controls.

4. Sound curves and characteristics of sound attenuators if required to meet the noise criteria. Certification:

   1. Submit four copies of performance curves, for CTI certified cooling towers, showing compliance with actual conditions specified, to the Resident Engineer two weeks prior to delivery of the equipment.

   2. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer. Certification by the manufacturer that the cooling towers conform to the requirements of the drawings and specifications.

   c Certification by the Contractor that the cooling towers have been properly installed, adjusted, and tested.

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**
INDUCED DRAFT - COOLING TOWER:


Framing:

1. Rolled structural steel shapes, hot-dip galvanized after fabrication or structural shapes cold formed from galvanized steel sheets or plates, complying with ASTM A653/A653M, and having G235 (Z700) coating.

Louvers:

1. Minimum splash out type. Material for the louvers shall be similar to the casing or may be PVC if formed integral with the fill material.

Fill:

1. PVC resistant to rot, decay and biological attack; with a maximum flame spread rating of five per ASTM E84 and fabricated, formed and installed by manufacturer to ensure that water breaks up into droplets.

Drift Eliminators: Same as fill material. Eliminators shall ensure a maximum drift rate of 0.002 percent of recirculated water.

Collecting Basin: Material same as the unit casing in accordance with manufacturer’s standard details. Outlet pump may also be of heavy glass-reinforced polyester (GRP) for depressed side outlet type. Provide a bronze make-up water float valve, overflow, drain not less than 50-mm (2 inches) suction connections, and outlet sump of size and depth to prevent cavitation and air entrainment in pump. Provide the following accessories:

1. Manufacturer’s standard bronze make up water float valve with an adjustable linkage.
2. Removable basin strainer, constructed of 304 stainless steel, shall have openings smaller than nozzle orifices.
3. Make-up water, overflow and drain connections.
4. Equalizer connection (multiple cooling tower systems).
5. Fume plate between adjacent cells (multi-cell units only).

Fans: Centrifugal or propeller type constructed of hot-dip galvanized steel, cast aluminum or aluminum alloy, glass fiber reinforced polyester or glass reinforced epoxy, statically and dynamically balanced at factory for quiet, and efficient operation. Forced-draft towers shall be centrifugal type only. Fans for induced-draft towers of 350 kW (100 tons) and less, and for forced-draft towers shall be belt driven.

1. For induced draft towers larger than 350 kW (100 tons), fan shall be driven through a gear reducer, or driven by a special V belt.
2. Gear reducer drive: Specially designed for cooling tower operation, with dynamically balanced drive shaft assembly or shock absorbent flexible coupling requiring no lubrication, cast iron case with readily accessible oil drum and fill, and self-contained oil reservoir sealed against water entrance.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
3. Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the manufacturer's standard.

4. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified as per CTI.

5. Motors and Motor Controllers, the following shall apply:
   a. Motors: Totally enclosed, epoxy encapsulated or totally enclosed fan cooled (TEFC) conforming to NEMA 250.
   b. Lubrication fittings shall be readily accessible outside the wet air stream. Provide access doors for inspection and cleaning.
   c. Fans over 1500 mm (60 inches) in diameter include a vibration cutout switch located in a protected position to effectively monitor fan vibration. Vibration switch shall be solid-state with adjustable time delay in NEMA 250, Type 4 enclosure. It shall stop fan motor under excessive fan vibration.

Safety: Provide fan guards, ladders, handrails and platform in conformance with the ANSI A10.18 as follows:

1. Fan Guard: Removable fan discharge with a rigid framed screen guard, installed over the fan cylinder.

2. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 3.6 meters (12 feet) shall have safety cage. Ladders shall extend to within 300 mm (one foot) of the grade or the roof deck surface.

3. Hand Railing: Steel or aluminum hand railings not less than 1070 mm (42 inches) high around perimeter of each fan-deck, or working surface 3.6 meters (12 feet) or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.

**EXECUTION**

**INSTALLATION**

A. Install cooling tower according to equipment manufacturer's written instruction.

B. Install cooling towers plumb, level and anchored on structure provided. Coordinate steel structure with cooling tower mounting requirements. If installed on concrete base follow manufacturers installation requirements and recommendations.

C. Install vibration controls according to manufacturer's recommendations.

D. Maintain recommended clearances for service and maintenance.

E. Piping:

1. Install piping, including flanges or union adjacent to cooling towers to allow for service and maintenance.

2. Install flexible pipe connectors at connections to cooling towers mounted on vibration isolators.

3. Install shutoff/balancing valves at cooling tower inlet connections.

4. Connect overflow drain and blow down lines to sanitary sewage system.

G. Electrical Wiring: Install electrical devices, components and accessories furnished loose by manufacturer, including remote flow switches and variable frequency drives.

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**
Field Quality Control

A. Provide the services of an independent testing and inspection agency to perform the field tests and inspections of non-CTI certified cooling towers.

B. If the cooling tower does not meet the specified performance, the Contractor shall make the tower corrections necessary to bring the tower into compliance with the specified performance including replacing the tower if necessary. Additional tests will be required until the tower meets the specified performance. Costs for the tower corrections or replacement, and tests shall be borne by the Contractor/manufacturer.

STARTUP AND TESTING

A. Provide the services of a factory-authorized and qualified representative to perform start up service.

B. Inspect field-assembled components and equipment installation, including piping and electrical connections.

C. Obtain and review performance curves and tables.

D. Perform startup checks, according to manufacturer's written instructions, and as noted below:
   1. Check clearances for airflow and tower servicing.
   2. Check for vibration isolation and structural support.
   4. Adjust belts to proper alignment and tension.
   5. Lubricate rotating parts.
   6. Operate equipment controls and safeties.
   7. Verify that tower discharge is high enough and it does not recirculate into air intake. Recommend corrective action.

E. Adjust water level for proper operating level and balance condenser water flow to each tower inlet.

F. Check water treatment water system, including blow down for proper operation of the tower.

G. Start cooling tower, including condenser water pumps and verify the tower operation.

H. Prepare and submit a written report of startup and inspection service to the Resident Engineer.

Training:

A. Furnish the services of a competent, factory-trained engineer or technician for a 2-hour period for instructing VA personnel in operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the Resident Engineer. Coordinate this training with that of the chiller, if furnished together.

SECTION 4

HVAC EQUIPMENT

1.0 SCOPE OF WORKS.

1.1 The Scope of this section comprises supply, erection, testing, commissioning, balancing adjustment and setting to work of the following systems conforming of these specification and accordance with drawing and of the schedule of quantities:

- Central & Split type air-conditioning system
- Ventilation system.

12 Contractor is to assume full responsibility for the correct functioning of the system and to carry any liability or other insurance or guarantee as may be necessary to protect all parties in this regard.
1.3 Contractor shall be responsible for coordination with other trades and services and shall provide all materials, labour and supervision, equipment, tools, appliances, services, etc. for carrying out the following items of work:

- Supply and install of air conditioning and ventilation plant and equipment.
- Insulated ductwork complete with air terminals, dampers, supports, etc.
- Insulated chilled water pipework complete with valves, fittings, supports and its accessories etc.
- Electrical Controls and control panels.
- Motor control centres and starter panels complete with cabling and earthing from the panels to the respective equipment. Power supply upto the panel shall be the responsibility of the electrical contractor.
- Power supply to fan coil units, air handling units, Ventilation fans etc. Electrical power supply terminating in an isolating switch within 2 metres of the equipment shall be the responsibility of the electrical contractor.
- Insulated drain piping from each air handling unit/fan coil unit to the nearest drain point. The drainage contractor shall be responsible for provision of a floor drain in each mechanical room.

1.4 The contractor shall also include all overheads at office and site, labour, sundries, plant, appliances and consumable both for the works and for balancing, testing & commissioning, and during the maintenance period.

2.0 DESIGN PARAMETERS

Design, in general, shall be based on ASHRAE recommendation with the following particular requirements:

2.1 DESIGN TEMPERATURE CONDITIONS

a) External
   Summer - 108 ° F DB & 75 ° F WB.
   Monsoon - 101 ° F DB & 83 ° F WB.
   Winter - 50 ° F DB & 43 ° F WB
b) Internal - 72+-/ - 2 deg F & 60 % RH
c) Performance Base: - Nasik - Elevation level conditions.

2.2 VENTILATION REQUIREMENTS

As shown on ventilation plans.

2.3 NOISE LEVELS – As per ASHRAE stds for various applications

2.4 DESIGN CRITERIA

2.4.1 Chilled Water to Cooling Coils

Chilled water inlet temperature : 44 °F
Chilled water outlet temperature : 55 °F
Maximum velocity of water through pipework: 2.0 (m/s)

Pipes to be sized for full flow rate of all cooling coils.
Maximum coil face velocity : 2.5 (m/s)

2.4.2 Air Distribution

Duct Velocity, supply : 1250 – 1400 FPM
Duct velocity, return : 1100 – 1250 FPM

2.6 PRESSURIZATION PHILOSOPHY

Fresh air requirements to each zone shall be generally determined by the level of dirty extract to that same zone, or to a value as required for the levels of occupancy in each zone.

Areas requiring no dirty extract shall be positively pressurized or maintained neutral as recommended by ASHRAE.

Areas requiring dirty extract shall be pressurized delta negative.

The whole building is positively pressurized to avoid any hot air infiltration.

2.7 FIRE PHILOSOPHY AND SMOKE MANAGEMENT

Also, fire dampers shall be positioned in all air ductwork crossing fire walls/slabs as shown in the drawings. They shall be triggered from a fusible link connection sited in the damper.

2.8 AIR INTAKE SYSTEM

Galvanized sheet steel Fresh air intake louvers with bird screens, filters and damper shall be provided in the clear openings in masonry walls thru infiltration and Fresh air package wherever specified on the drawings. Air intake louvers shall in general be located as far away as possible from extract louvers and drainage vent stacks to avoid short circuiting of dirty air.

3.0 AIR HANDLING UNITS – FLOOR MOUNTED TYPE

Medium Pressure Cabinet Type All Sheet Metal Air Handling Units with static Pressure capability of 1000 Pa WC & above have been specified.

The Air Handling Units shall consist of the following sections:

13.23 Mixing Box with dampered inlet for return air.
13.24 Pre Filter Section (with Rough Filter & 30% efficiency (EU-4) Pocket Filter)
13.25 Face and bypass section with motorized dampers
13.26 Chilled Water Cooling Coil Section with SS-304 drain pan.
13.27 Fan section with drive package
13.28 Fine Filter Section (EU 9 - 95% efficiency down to 5 micron)
13.29 HEPA EU 14 filter section 99.5 % efficiency down to 0.5 micron
13.30 Plenum section with flexible connectors
13.31 Each AHU is supplied with a factory fitted GI powder coated, opposed blade volume control damper to facilitate air balancing.

The unit casing shall have a perimeter frame with a wholly modular system based on custom-made panels and reinforced vertical sections. The panels shall be fixed to the perimeter frame from outside the unit and screw heads shall be covered with nylon sleeves and caps, yielding of clear external surfaces free from bolt and bolt-head projections.

The entire unit shall be of sturdy construction to ensure freedom from vibration & noise during running.

The Panel shall be of double-skinned construction made of pre-coated GSS on outside and 0.6 mm galvanized sheet inside. They shall incorporate 25 mm thick sandwich for medium pressure AHU and for high pressure AHU it should be 40 mm thick injected HFC – Filler PUF Insulation material sandwiched between the external and internal sheets. The panels shall be coated with factory applied heat-hardened polyester based powder paint. All internal corners to be with covering sections of
extruded aluminum. The AHU is constructed on a thick fabricated GSS channel.

The entire framework shall be mounted on heavy gauge aluminum alloy channel base. The panels shall be sealed to the framework by heavy-duty ‘O’ ring gaskets held captive in framed extrusion. All panels shall be hinged. Hinges shall be made die cast aluminum with stainless steel pivots. Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixtures and gaskets shall be concealed. The fan section is provided with suitable airtight tight access door for ease in serviceability of and motor. User-friendly nylon handles can be operated from both inside and outside the casing.

Internal surface shall be smooth & shall be cleanable without any projection.

All AHU shall incorporate thermal breaks.

**Centrifugal Fans:**

The fan shall be of DIDW Centrifugal type with backward inclined airfoil blades designs suitable for belt drive. The fan shall be imported, factory tested and assembled by original manufacturer. The blades shall be of mild steel backward curved airfoil blades with polyester powder coating finish.

The fan assembly shall be statically and dynamically balanced to ISO 194 & AMCA 204/3 – G 4.0 std certified. The fan shall be suitable for operating & deliver 15% excess of design airflow. Fans are selected based on higher efficiency and lower noise level.

Fans, as shown on the Drawings and having the capacities, characteristics and starting equipment shown on the schedule, shall be belt driven and of the centrifugal type, especially selected for AC & ventilating work. The wheel & housing shall be fabricated from heavy gauge galvanized steel. Fan shall run in perfect balance at all speeds, up to a 15% increase above the speeds indicated on the schedule, without noise or vibration in any fan or motor. Blades shall be die-formed, true to shape and held in place by rivets or welds. Fan shaft shall not reduce in diameter at the outboard bearing (opposite of drive end).

Fans shall be provided with anti friction bearing of the types specified herein. The fan bearings shall be mounted on the fan wheel and not on the panels of the casing. The fan – motor unit shall be totally isolated from the casing using cushy foot or equivalent vibration isolators beneath the structural frame. The bearing life shall be 200,000 hrs and they shall be self lubricating. Shafts shall be made of the best quality steel, turned and ground to close tolerance and shall run true and in perfect balance. All fans shall be furnished with variable inlet vanes.

All v-belt drives shall be designed for a minimum of 50% overload. Where more than one belt is required, matched sets shall be used. All belt drives shall be furnished with belt guards.

The impeller and shaft of the fan shall be both statically and dynamically balanced. Similarly, the fan as well as the motor shall also be dynamically balanced. The successful contractor shall furnish certificates to the effect that such dynamic balancing has been carried out. The results of balancing so carried out shall also be furnished in the certificates.

Fan and motor is mounted on a fabricated slide rail. A specially designed motor mounting base plate allows adjustment of the belt tension without disturbing motor alignment. Flexible fire retardant canvas connection is provided at the fan outlet.

The fan housing with motor shall be mounted on a common extruded aluminum base mounted inside the air handling unit on anti-vibration mounts.

The fan outlet shall be connected to casing with the help of fire retardant fabric, mounted on aluminum extruded channels, acting as a flexible connection for anti-vibration.

All sections shall incorporate access panels with quick release latches for maintenance.

More generally, it is recommended at the following features incorporated in the medium pressure units.

- There will be only one impeller
- Bearings for the fan shaft shall be installed on a fan scroll and not on the casing of the unit.
- Flexible connections shall be provided between the fan outlet and the unit casing.
- Access doors of ample size with hinges and handles shall be provided to facilitate the entry of service personnel into the casing of the unit.
- All doors shall be provided with limit switches to interlock with fan motor.
- Fan chamber shall be provided with incandescent lamp protected with wire guard, which will come on when the door is opened.
- View port is provided on the fan door panel, which helps to monitor the fan and motor status. Marine lamp provided easy visibility.

Product Data: Submittal data for approval for all fans of every description furnished under this section of these Specifications driven by 5 (five) HP and larger motors shall include the following:

1. Fan curves with specified operating point clearly plotted. The recommended range of operation shall be stable.
2. Data to substantiate that fans on duct systems will operate in a stable range at 1/2" (one-half inch) S.P. above scheduled static pressure with motors sized accordingly.
3. Fans shall be capable of operating stably at reduced loads imposed by means of variable speed drives.
4. Data on sound power levels for both fan inlet and outlet at rated capacity.
5. Electrical characteristics and connection requirements.
6. All data on fan accessories.

Performance Ratings:

A. Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
C. Fabrication: Conform to AMCA 99.
D. Performance Base: 500m above Sea level conditions.
E. Temperature Limit: Maximum 300 degrees F.
F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

CHILLED WATER COILS:

A. Water coil capacities, pressure drops, capacity ratings and selection procedures shall be in accordance with ARI Standard 410-87. Necessary factory test certificates to be produced by the manufacturer/contractor.
B. Chilled water coils shall be of the extended surface type meeting all conditions and having the minimum face area and pressure drops scheduled on the Drawings, and shall have same end supply and return connections unless otherwise indicated. Coils shall be constructed of copper tubes 1/2" O.D. with .035" thick minimum wall thickness and Aluminum fins permanently bonded to the tubes by mechanical expansion. Coils shall have a maximum of 12 fins per inch, and a maximum of 6 rows. If additional cooling capacity is necessary, the additional capacity shall be provided by an additional coil, with an additional access section between the coils, and the coils shall be piped in series, counterflow to the direction of airflow. Aluminum fins on plate coils shall be .006" thick.
C. All coil headers and connections shall be of heavy gauge seamless hard drawn copper tubing with penetrations for connection of core tubing by die-formed intrusion process with resulting contact depth between the header wall and core tubing of not less than .090". Joints between core tubing and header shall be of recess swage design to allow a large mating area for build up of brazing materials to give increased strength to the joint. Supply and return connection of brass or copper shall be terminated.
D. Coils shall be designed and certified by the manufacturer to operate to scheduled face velocity plus 10% without moisture carry over. Each cooling coil section shall be provided with a Steel frame/casing, including tube sheets, no lighter than 16 gauge. Frame members shall extend over the ends and edges of the coils and shall be constructed with formed holes for tubes, permitting free expansion and contraction of coil sections while supported by an extended surface of the frame. Intermediate tube support sheets of 316-L stainless steel shall be provided in all coils having tube lengths in excess of 48": on long coil sections the spacing of coil supports shall not exceed 48”. All intermediate supports shall be welded to coil frame members and fabricated with formed tube holes to support the penetrating tubes. Heating coil construction shall be similar, except casting frame and intermediate supports may be G90 galvanized material.

E. Condensate from chilled water coils shall be piped to the nearest convenient floor drain. The pipe size shall be 1” minimum diameter, insulated as specified for chilled water piping. A trap of a minimum depth of 6 inches shall be provided in this drain line to prevent the escape or entry of air through the drain piping.

F. Pressure test all coils to 350 psi under water. The coil section shall be drained independently of the fan section.

Drain trays shall be provided for all cooling coil, sections as well as dummy sections and fan casing complete with drain connection for proper drainage of water. Drain trays shall be of 18 G Stainless Steel, Slopes shall be provided from all sides to the drain point; 100% drainability shall be ensured.

Filter Section shall incorporate pre filters and bag filters.

- Pre Filter Efficiency of not less than 30% by ASHRAE standard 52.1 – 1992 corresponding to Eurovent standard EU-4. Filter capacity shall be not less than 5000 cmh at a pressure drop not exceeding 9mm when filter is clean.

1. Fine Filter Efficiency of not less than 95% by ASHRAE standard 52.1 – 1992 corresponding to Eurovent standard EU-7. Filter capacity shall be not less than 5000 cmh at a pressure drop not exceeding 15mm when filter is clean.

2. HEPA filter Efficiency of not less than 99.5% by ASHRAE standard 52.1 – 1992 corresponding to Eurovent standard EU- 14. Filter capacity shall be not less than 5000 cmh at a pressure drop not exceeding 35-40 mm when filter is clean.

Necessary pressure connections to be provided between the filter sections to measure differential pressure across the filter.

All access doors, coil connections etc., shall be provided on one side of the unit. In other words, access to the other side of the unit should not be necessary for any purpose whatsoever.

Special care shall be taken to ensure that doors, handles, hinges etc. shall be robust enough to withstand heavy industrial usage.

Silicone sealants shall be applied to all joints – both on the inside of the AHU.

The vibration of the AHU fans (as measured on the bearing block after assembly) Shall not exceed a peak to peak displacement of 100 microns. The computerized section and test certificate for the cooling coil shall be submitted by the supplier.

Motors: Three phase squirrel cage motors suitable for 415/3/50 power.

Enclosures shall be of the squirrel cage induction motor of TEFC type with a service factor of 1.15 and Class F insulation of IP55 protection and suitable for 65 deg C. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1500 RPM at maximum air flow. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage high efficiency induction type with standard NEMA frame sizes. Motors 1 HP and larger shall have integral frames. Starting Torque shall be between one and one and one-half

Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory prepacked with a no detergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for 10,200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

The tenderers shall describe the tests that will be conducted at their / manufacturers works on the Air Handling Units. They shall furnish a test certificate to the effect that such tests have been duly performed on the AHUs. Test certificate shall be furnished for all bought out items like filters, motor, manometer, etc., Tests shall be conducted on all AHUs at the factory for measurement of delivery vs. static pressure, total pressure, BKW, efficiency & noise level at 100%, 80%, 60%, 50% & 40% speeds. Owners / consultants will witness the testing of 1 or 2 AHUs of each specified type at the factory. The contractors shall intimate in advance the date of the tests, which they will witness at their option.

Further, all AHUs shall be leak-tested at 150 mm static pressure using an external testing rig. The test shall be conducted to Class ‘D’ level applicable for ducting as per STD DW 141/1 42. The test rig shall include an external fan with arrangements for varying the airflow instruments for measuring static pressure, airflow etc., The tenderers shall afford every facility for the accepting officer or his authorized representative to witness the tests if they so desire.

The Accessories shall include the Outlet plenum, flanges, flexible connections at supply and discharge, marine lamps, sight glass, belt guard, limit switch, Differential pressure switches & gauges for each filters, air flow switch across the fan section.

CABINET TYPE AIR HANDLING UNITS CEILING / VERTICAL TYPE

Cabinet Type Air Handling Units shall consists of the following sections:

- 9.1 Filter section with Panel type Rough Filter
- 9.2 Bag filter or Microvve filter 10 micron filter
- 9.3 Cooling Coil Section with cooling coil and bypass damper
- 9.4 SS Drain Pan
- 9.5 Fan Section with Fan
- 9.6 Supply air plenum with dampered openings.

Vertical Air Handling units are designed to occupy lesser floor space than the horizontal unit. The unit casing shall have a perimeter frame with a wholly modular system based on custom-made panels and reinforced vertical sections. The panels shall be fixed to the perimeter frame from outside the unit and screw heads shall be covered with nylon sleeves and caps, yielding of clear external surfaces free from bolt and bolt-head projections. The entire unit shall be of sturdy construction to ensure freedom from vibration during running.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

The panels shall be of double-skinned construction with both skins being of GI. They shall incorporate 25 mm thick injected HFC – Filter PUF insulation material Sandwiched between the external and internal sheets. The panels shall be coated with factory applied heat-hardened polyester based powder paint. All internal Corners to be with covering sections of extruded aluminum. Internal surface shall be
Smooth and shall be cleanable without any projection. All sections shall incorporate access panels with quick release latches for maintenance.

The filter section shall consist of two-stage filtration. First stage shall be Panel type Prefilters. The Pre filters shall have an efficiency of 90% down to 20 microns by Arrestance Test. The filter pressure drop shall not exceed 6 mmwg when clean and 12 mmwg when fully loaded. Second stage filters shall have an efficiency of 90% down to 10 microns by Arrestance Test. The filter pressure drop shall not exceed 12 mmwg when clean and 25 mm wg when fully loaded.

The fan shall be DIDW centrifugal type. Forward curved blades shall be of GSS while blades of other shape shall be of MS, treated and epoxy painted after manufacture (if of MS). The fan assembly shall be statically and dynamically balanced.

The fan bearings shall be mounted on the fan scroll and not on the panels of the casing. The fan-motor unit shall be totally isolated from the casing using spring steel mounted vibration isolators beneath the structural frame and by flexible connections between the fan mouth and the outlet connection on the fan section.

More generally, it is recommended at the following features incorporated in the medium Pressure units:

- There will be only one impeller.
- Impellers shall have forward curved blades of aerofoil design.
- The fan and motor shall be assembled together on a common MS frame, which shall be mounted within fan casing on cushy foot or equivalent vibration isolators.
- Bearings for the fan shaft shall be installed on a fan scroll and not on the casing of the unit.
- Flexible connections shall be provided between the fan outlet and the unit casing.
- Access doors of ample size with hinges and handles shall be provided to facilitate the entry of service personnel into the casing of the unit.
- All doors shall be provided with limit switches to interlock with fan motor.
- Fan chamber shall be provided with incandescent lamp protected with wireguard, which will come on when the door is opened.

Coils shall be of the fin and tube type having aluminum fins firmly bonded to copper tubes. All tubes shall be in staggered pattern. Headers shall be of MS and all tube connections to headers and return bends shall be brazed with silver brazing alloy.

Capacity of the coils shall be as shown in section III – Equipment Schedule.

The coil section shall be drained independently of the fan section.

Heating coil section shall incorporate heating coil made out of copper tubes with aluminum fins. All other constructional details shall be same as cooling coils.

Drain trays shall be provided for all cooling coil, sections as well as dummy sections and fan casing. Drain trays shall be of 18 G stainless steel. Slopes shall be provided from all sides to the drain point; 100% drainability shall be ensured.

Necessary pressure connections to be provided between the fitter sections to measure differential pressure across the filter.

Where specified the high velocity filter section shall incorporate cleanable type (pre) filters. Face velocities upto 4.25 mps (850 fpm) are permissible. The filter media shall be extruded sections of high – density polyester or similar synthetic material, which shall be housed, in metallic frame with GI wire mesh support from both side. The efficiency of the filters shall be equivalent to or not less than 90% down to particle size of 20 microns. Only Flat Filter Sections suitable for accommodating filters of depth not greater than 150 mm shall be provided. The depth of the filter section shall not exceed 150 mm in the direction of airflow.

The filters and the filter section shall be so installed that filters can be readily removed for cleaning.

The empty section shall also be of double-skin construction & shall be provided wherever called.
All access doors, coil connections etc. shall be provided on one side of the unit. In other words, access to the other side of the unit should not be necessary for any purpose whatever.

Special care shall be taken to ensure that doors, handles, hinges, etc. shall be robust enough to withstand heavy industrial usage.

Silicone sealants shall be applied to all joints – both on the inside of the AHU.

The vibration of the AHU fans (as measured on the bearing block after assembly) shall not exceed a peak – to-peak displacement of 100 microns.

For all AHUs serrated rubber pads shall be provided for vibration isolation.

The tenderers shall describe the tests that will be conducted at their manufacturers works on the Air Handling Units. They shall furnish a test certificate to the effect that such tests have been duly performed on the AHUs. Test Certificate shall be furnished for all bought out items like filters, motor, manometer, tachometer, and static pressure tester etc.,

Tests shall be conducted on all AHUs at the factory for measurement of delivery vs. static Pressure, total pressure, BKW, efficiency & noise level at 100%, 80%, 60%, 50% & 40% speeds. Owners / Consultants will witness the testing of 1 or 2 AHUs of each specified type at the factory. The contractors shall intimate in advance the date of the tests, which they will witness at their option.

Further, all AHUs shall be leak-tested at 150 mm static pressure using an external testing rig. The test shall be conducted to Class ‘D’ level applicable for ducting as per STD DW 141 / 142. The test rig shall include an external fan with arrangements for varying the airflow instruments for measuring static pressure, airflow etc.,

The tenderer shall afford every facility for the accepting officer or his authorized representative to witness the tests if they so desire.

Vertical AHU’s – Shall be same constructional features as above, however the unit shall be suitable for Floor standing (mounted) application with a MS frame / pedestal.

FRESH AIR UNITS

Medium pressure cabinet type all sheet Metal Fresh Air Units with static pressure capability of upto 50 mmwg and above have been specified.

The VAU shall consist of the following sections for all VAUS:

(a) Air Intake Section
(b) Filter Section (with Rough Filter and 30% efficiency 9EU-3) pocket filter)
(c) Fan Section

The unit casing shall have a perimeter frame with a wholly modular system based on standardized panels and reinforced vertical sections. The panels shall be fixed to the perimeter frame from inside the unit yielding clear external surfaces free from bolt and bolt head projections.

The entire unit shall be of sturdy construction to ensure freedom from vibration during running.

The panels shall be of double-skinned construction with both skins being of GI. They shall incorporate 25mm thick injected HFC Filler PUF insulation material sandwiched between the external and internal sheets. The panels shall be coated with factory applied heat hardened polyester based powder paint. All internal corners to be with coving sections of extruded aluminum.

The fan shall be DIDW Forward curved centrifugal type. The blades shall be of mild steel Forward curved blades with polyester powder coating finish. The fan assembly shall be statically and dynamically balanced to ISO 1940 & AMCA 204/3 – G 4.0 std.
The fan bearings shall be mounted on the fan wheel and not on the panels of the casing. The fan-motor unit shall be totally isolated from the casing using cushy foot or equivalent vibration isolators beneath the structural frame and canvas connections between the fan mouth and the outlet connection on the fan section.

A single square flange outlet shall be provided for the fan.

The impeller and shaft of the fan shall be both statically and dynamically balanced. Similarly, the fan pulley as well as the motor pulleys shall also be dynamically balanced. Multiple speed pulleys to be provided to adjust the air flow rate required at site. The successful contractor shall furnish certificates to the effect that such dynamic balancing so carried out shall also be furnished in the certificates.

All sections shall incorporate access panels with quick release latches for maintenance.

More generally, it is recommended at the following features incorporated in the medium pressure units.

-There will be only one impeller.
-Impellers shall have forward curved blades
-The fan and motor shall be assembled together on a common GI frame, which shall be mounted within fan casing on cushy foot or equivalent vibration isolators.
-Flexible connections shall be provided between the fan outlet and the unit casing.
-Access doors of ample size with hinges and handles shall be provided to facilitate the entry of service personnel into the casing of the unit.
-All doors shall be provided with limit switches to interlock with fan motor.
-Fan chamber shall be provided with Compact Fluorescent (CF)-1 1 lamp protected with wireguard, which will come on when the door is opened.

Filter Section shall incorporate bag filters

-Efficiency of not less than 30% by ASHRAE standard 52.1 – 1992 corresponding to Eurovent standard EU-3. Filter capacity shall be not less than 5000 cmh at a pressure drop not exceeding 9mm when filter is clean.

Necessary pressure nozzles to be provided between the filter sections to measure differential pressure across the filters.

The filters and the filter section shall be so installed that filters can be readily removed for cleaning.

All access doors etc., shall be provided on one side of the unit. In other words, access to the other side of the unit should not be necessary for any purpose what so ever.

Special care shall be taken to ensure that doors, handles, hinges, etc. shall be robust enough to with stand heavy industrial usage.

The vibration of the fans (as measured on the bearing block after assembly) shall not exceed a peak – to-peak displacement of 100 microns.

For all FAUs serrated rubber pads shall be provided for vibration isolation.

The tenderers shall describe the tests that will be conducted at their / manufacturers works on the ventilation Air Units. They shall furnish a test certificate /s to the effect that such tests have been duly performed on the FAUs. Test Certificate shall be furnished for all bought out items like filters, motor, manometer etc.,

SIGNATURE OF TENDERER WITH SEAL

Tests shall be conducted on all FAUs at the factory for measurement of delivery vs. static Pressure, total pressure, BKW, efficiency & noise level at 100%, 80%, 60%, 50% & 40% speeds. Owners / Consultants shall be intimated in advance the date of the tests, which they will witness at their option.

The tenderer shall afford every facility for the accepting officer or his authorized representative to witness the tests if they so desire.
Exhaust Air units:

The description shall be similar to the Fresh air units specs mentioned above. However the fan shall be SISW spark resistant fan.

APPLICATION

For supply or exhaust application in commercial and industrial buildings.

CONSTRUCTION

"Pittsburg lock" form housing manufactured in galvanized sheet steel for all sizes except 1250 and above, in mild steel finished with polyester powder coating. The wheel having forward curved blade is made of galvanized sheet steel.

TESTING

Both air and sound performance ratings are based on test to AMCA210 and AMCA300 Standards.

All wheels are statically and dynamically balanced to ISO1940 and AMCA204 - G2.5 Standards.

4.0 FAN COIL UNITS & CASSETTES UNITS

FAN COIL UNITS:

4.1 Units shall be complete with chilled water coil(s), fan(s), motor(s), drain pan, and all required wiring, piping, controls and special features.

4.2 Horizontal Base Unit with Plenum for concealed installation shall have a factory installed, galvanized steel plenum section and throw away filter. The plenum shall be either bottom or rear return lined with 12mm thick glass fiber insulation and include a removable panel to provide a access to the fan/motor assembly.

4.3 Fans shall be direct driven, double width fan wheels shall have forward curved blades, and be statically and dynamically balanced.

4.4 Fan motors shall be 3-speed permanent split capacitor type with sleeve type bearings

4.5 Standard base unit shall be equipped with a 3/4-row coil (minimum) for installation in a 2-pipe system. Coils shall have 12mm copper tubes, aluminum fins bonded to the tubes by mechanical expansion and have a working pressure of 16 bar. Each coil shall have a manual air vent and sweat connections for copper tubes.

4.6 The drain pan shall be constructed of galvanized steel extending the entire length and width of the coil(s) and pitched for drainage.

4.7 Insulation and adhesive shall meet NFPA-90A requirements for flame spread and smoke generation.

4.8 Units shall be provided with 25mm thick throw washable filters.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

4.9 Control valves shall be modulating type three way for FCU’s capacity of 4.8KW and above and ON-OFF for capacity below 4.8KW.

4.10 Fan coil units shall be selected at high speed.

4.11 Fan coil unit for exposed application will be same construction features as listed above, however all the above components will be housed in a heavy gauge (18G) GI decorative cabinet finished with baked enamel powder coating of beige type. The
CASSETTE TYPE UNITS

The cassette type unit shall be a combination of the supply air slot, return air grille fan casing and cooling coil. No connection of ductwork is allowed

Each cassette type unit shall be provided with combined room temperature sensor
Complete with 3-speed controller

CHW Coils are of the corrugated fin-and-tube-type, constructed of seamless copper tubes of minimum thickness 0.014 inches (0.356 mm), mechanically bonded to aluminum fins. End plates and tube support sheets are 18 gauge galvanized steel formed to provide structural strength. Each coil to be pressure tested in the factory at not less than 300-psi (2070 kPa) air pressure. Coils conform to ARI 410.

Each cassette type unit shall be provided with stainless steel drain pan situated beneath the cooling coil and arranged so that all moisture will collect in and drain from the pan. Drain pans shall be insulated externally with 9 mm thick electrometric nitrile rubber insulation. Drain pan shall be fitted with a drainpipe, which shall be connected via suitable runs (correctly laid to fall) to the drainage system. Drain pans shall have copper male connectors for connection to the condensate drain. The connector shall be positioned to ensure rapid discharge of moisture from the pan.

Built-in condensate pump shall be provided for the removal of condensate. A water sensing system with low, high and warning limits shall be provided which actuates the running of condensate pump at high water limit and trigger the alarm system at warning level. When water level reaches the warning limit, the sensing system shall cut off the unit operation. An alarm signal shall be given locally. The signal shall be connected to CCMS or remote indication system as specified. Condensate pump shall be designed to run continuously at some essential areas as specified. The power source for condensate pump and the associated control system shall be independent from that of cassette unit such that the pump can still be operated after the units has been switched off.

The filter media shall be of the washable type and shall be enclosed in a one piece formed stainless steel frame with covers flush mitered and reinforced by a die-formed inverse bead.

Automatic/manually adjustable louvers for directional airflow shall be provided for supply air slot in each unit. Options shall be given to choose from 2-way,3-way or 4-way supply air discharge

Fan motor shall be PSC squirrel cage, totally enclosed, fan cooled type. The motors insulation class and protection shall be acc. IEC-Standard. Motor shall be suitable for 3-speed operation.

After finalization of contract the successful bidder shall access the static pressure calculations and submit to consultant for approvals.

In the event that the Consultant requires further information on any of the proposed items the Contractor shall arrange visits to similar units, which he has installed. In any Event, all equipment proposed for the project shall be currently installed and working satisfactorily locally. The Contractor must be able to provide references of at least three satisfied Owners and Consultant with equipment of the particular size and model proposed.

HI WALL MOUNTED SPLIT SYSTEM

4.12 GENERAL
Unit shall be a air cooled, split type air conditioner consisting of one outdoor unit and a matching indoor unit, each having capability to cool independently for the requirements of the rooms.

Compressor shall be equipped with rotary type and mounted on rubber in shear foot mounts.

Outdoor unit shall be suitable for match connection to Wall mounted type models.

The maximum one run of refrigerant piping shall not exceed 35 feet, oil entrainment to be planned if required by the manufacturer/HVAC contractor.

4.13 OUTDOOR UNIT

The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed form rust-proofed mild steel panels coated with a baked enamel finish.

The outdoor unit shall have rotary scroll compressors and be able to operate in adverse conditions prevailing in the site without malfunctioning.

The noise level shall not be more than 59 dB(A) at normal operation measured horizontally 1 m away and 1.5m above ground.

The outdoor unit shall have side discharge and should be allowed for side by side installation.

4.14 COMPRESSOR

The compressor shall be of highly efficient rotary scroll type and equipped with all necessary safety and standard controls necessary for proper and safe operation. These compressors have a self-regulating crankcase heater, improved internal pressure relief valve, which provides high pressure protection to the refrigerant system and rubber vibration isolators for quiet and efficient operation.

4.15 AIR COOLED CONDENSER

The condenser coil is of corrugated fin & tube type, constructed of seamless copper tubes with wall thickness of 0.014” (0.356mm), and mechanically bonded to aluminium fins. All copper tube return bends have 0.022” (0.56mm) wall thickness. Tube support sheets are of galvanized steel formed to provided structural strength. Tubes are circuited to ensure minimum pressure drop and maximum heat transfer. Each coil is completely dehydrated, charged and sealed at the factory upon completion of tests.

The fans are propeller type and direct-driven, front discharge and provided with fan guards. Units are equipped with totally enclosed fan motors for greater reliability and dependable performance for many years. Inherent thermal protection is automatic reset type.

SERVICE VALVES

Both suction and liquid service valves are brass, back seating type with flare connections. Valves are externally located so refrigerant tube connections can be made quickly and easily. Each valve has a gauge pressure port for ease of checking refrigerant operating pressures.

LOW PRESSURE SWITCH

Auto reset SPST switch activated by refrigerant pressure locks out the compressor, if the refrigerant pressure falls below 25 PSIG. Also provides additional protection against evaporator freeze up due to loss of indoor airflow.

inverter control capable of changing the speed in accordance to the cooling load requirement.

4.16 HEAT EXCHANGER

As described above under Air cooled condenser.

4.17 REFRIGERANT CIRCUIT

SIGNATURE OF TENDERER WITH SEAL
The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves. All necessary safety devices shall be provided to ensure the safety operation of the system.

4.18 SAFETY DEVICES

The following safety devices shall be part of the outdoor unit:

High Pressure Switch, Low Pressure Switch, Fan Motor Safety Thermostat, Inverter Overload Protector, Over Current Relay, Fusible Plugs, Fuses.

4.19 OIL RECOVERY SYSTEM

Unit shall be equipped, with an oil recovery system to ensure stable operation with long refrigerant piping.

4.20 INDOOR UNIT

Each Indoor unit shall be as shown in the drawings and can be of the ceiling mounted cassette type (Double flow type), or ceiling mounted cassette type (Multi-flow type), or ceiling mounted built-in type, or ceiling mounted duct type, or ceiling suspended type, or floor standing type, or concealed floor mounted type, or Hi-Wall type, or ceiling mounted cassette corner type as specified in scope of work. It shall have electronic control valve which control refrigerant flow rate in respond to load variations of the room. The indoor unit should be equipped with LCD display type.

The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

(q) The address of the indoor unit shall be set automatically in case of individual and group control.

(r) In case of centralized control, it shall be set by liquid crystal remote controller.

4.21 HI-WALL UNITS

The Hi-wall type unit shall be a combination of the supply air & return air grille, fan casing and cooling coil. No connection of ductwork is allowed.

Each Hi-wall unit shall be provided with combined room temperature sensor complete with 3-speed controller.

DX Coils are of the corrugated fin-and-tube-type, constructed of seamless copper tubes of minimum thickness 0.014 inches (0.356 mm), mechanically bonded to aluminum fins. End plates and tube support sheets are 18 gauge-galvanized steel formed to provide structural strength. Each coil to be pressure tested in the factory at not less than 300-psi (2070 kPa) air pressure. Coils conform to ARI 410.

The filter media shall be of the washable type and shall be enclosed in a one piece formed stainless steel frame with covers flush mitered and reinforced by a die-formed inverse bead.

Automatic/manually adjustable louvers for directional airflow shall be provided for supply air slot in each unit.

Fan motor shall be PSC squirrel cage, totally enclosed, fan cooled type. The motors insulation class and protection shall be acc. IEC-Standard. Motor shall be suitable for 3-speed operation.

4.22 CONTROL

Standard control as applicable for Hi wall splits shall be provided.

(i) Sleep Mode
(ii) Wireless controller with LCD
(iii) Quiet mode Operation
(iv) Auto Re-start Function
5.0 Expansion Tank

Expansion Tank - Closed pre-charged pressure vessel designed to absorb expansion effects of Chilled water systems and maintain proper system pressurization. The tank shall take care of the expansion of water due to the temperature variation in the system shall be provided in the chilled water circuit. Shell construction of Carbon steel, bladder of butyl rubber to eliminate tank corrosion and water logging. Stds ASME, working pressures of 125 psig and 240°F. Expansion tank to take care of the expansion of water due to the temperature variation in the system shall be provided in the chilled water circuit. Tanks to be with all accessories & connections. The cost of Tank shall cover all valves, vents, gauges, fittings and required accessories.

The tank shall be epoxy coating from inside and butilminised coating from outside. The assembly shall also include monobock circulating pumps.

The tank shall have a neoprene rubber diaphragm rated for continuous operation at 10 Bar NP with GI cladding.

The tank shall be complete with all tappings for inlet (which may also be the drain,) air recharge, and pressure relief.

6.0 Air Separator

An adequately sized centrifugal type Air separator to remove air from closed chilled water pipe circuit. The unit shall have inlet and outlet connections, tangential to the vessel shell. Vessel shall diameter to be three times the nominal inlet/outlet pipe diameter.

The unit shall have internal stainless steel air collector tube wit 4 mm diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit.

The unit shall have a removal galvanized steel system strainer with suitable diameter perforations and a free area of not less than five times the cross sectional area of connecting pipe. A blow down shall be provided to facilitate routine cleaning of the strainer.

7.0 FANS CENTRIFUGAL – CABINET TYPE UNITS

Cabinet type units casing shall be constructed as per the details mentioned in this section under article 3.0. The units shall be suitable for exhaust and fresh air handling. The AHU shall comprise of Fan and filter with related accessories.

Fans - Furnish, install and connect up complete, all supply, return, exhaust, transfer and exhaust fans. All fans shall be of the non-overloading centrifugal type.

Fans shall have direction of rotation, discharge direction indicated on the casing. Fan arrangement shall be selected to suit the space conditions.

Fan housing shall be rigidly built and braced. Where fan scroll is 480 mm or more in width provide access door with frame and gasket. All access doors shall be so fabricated that the inner surface is flush with the inside of the scroll. Raised frame doors of the pan type shall be provided on all fans where insulation is required. The doors shall be secured to the frame by hand-grip latches and shall be provided with lift handles. Bolted doors are not acceptable.

Fans shall not produce excessive noise as compared to units of like size and power when used in conjunction with the specified vibration isolation. Fan manufacturers shall furnish for approval for each fan certified sound power ratings with an octave band analysis and also the volume- horsepower- pressure characteristic curves from shut-off to free delivery. Wheels shall have ample strength and shall be statically and dynamically balanced to avoid vibration and shall have blades designed to ensure quiet efficient operation.

Fans, unless otherwise indicated, shall be belted to respective motors by “V” belt drives. Sheaves shall be cast steel. Drives requiring 2 grooves or more shall have variable pitch motor sheaves and
companion type fan sheaves. Belts shall have a rated capacity of not less than 150% of the motor horsepower. All "V" belt drives for integral horsepower motors shall have not less than two belts and shall have sufficient belt capacity to drive fans with one belt broken. Drives for fractional horsepower motors may have one belt rated at 200% of motor horsepower. If to balance an air system, a fan other than the one provided should be required, necessary changes shall be made in the "V" belt drive by the Contractor at his expense. Supply and install belt guards of perforated metal, or as approved for all sheaves and belts. Belt guards shall be grommeted at fan and motor shafts for ease in taking tachometer readings.

Each fan motor shall be sized to drive its respective fan when fan is operating at a speed (due to pulley adjustment) of 10% in excess of that required to meet fan performance, and when the fan requires the maximum power at this speed.

All fans shall be factory coated with one coat of primer and one coat of machine enamel. The interior of all fans and all wheels shall be painted as per manufacturer's standard.

All fans discharging directly up through the roof shall be equipped with a 38 mm casing drain which shall be piped to the nearest floor drain.

All fans scheduled to be arranged as belted vent sets shall have overhung wheels and motors mounted on a common base with the bearings. All such belted vent sets shall be furnished with weatherproof motor housings where located outdoors.

All double width, double inlet fans shall be provided with galvanized steel inlet guard screens.

7.0 **FANS, AXIAL.**

Axial flow fans shall be capable of giving the design flow.

Each fan shall be supplied with a suitably rated contractor/ starter/ isolator of approved pattern.

Fan casings shall be constructed of mild steel plates with angle stiffeners, with the casing hot dip galvanized after manufacture. The inlets and outlets of the axial flow fans shall be flanged for connection to the system. A drain plug shall be fitted and the casing designed to permit removal of the impeller.

An access door is to be provided on the casings of all fans. Casings shall cover both impeller and motor so that fans can be removed without disturbing adjacent ductwork or other components of the system.

All lubrication points are to be extended to the outside of the casing and in a position that will permit access in relation to the adjacent plant, services or building structure.

Impellers shall be die cast in Aluminum alloy and X-rayed during manufacture. The impellers shall be capable of running continuously at 20% in excess of the rated speed. The impeller shall be keyed and locked onto the shaft, which shall be statically and dynamically balanced and tested at overspeed before dispatch from the Manufacturer's works.

Flexible connections shall be supplied and installed at both inlet and outlet of each fan.

The fan bearings shall be of the sleeve type wherever possible. The bearings are to be truly aligned and rigidly mounted on to the casing.

Graphs of the performance curve of each fan are to be forwarded to the Consultant/Client together with a test report on the sound level at three diameters in a free field condition prior to the order being confirmed.

Blade angle shall be adjustable over at least a 30-degree range, with markings at the root to indicate the blade angle.

Axial flow fans are to be driven by electric motors of commercially silent pattern carrying a Makers guarantee in this respect. The motors shall be totally enclosed, fan cooled.

All motors are to be positioned to permit effective ventilation of the motor and all component parts of the fan.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
and motor are to be suitable to withstand the temperature conditions expected in the fan.

Electrical connections to the motors shall be in a totally enclosed terminal box secured to the exterior of the casing. Wiring within the axial flow fans shall be suitable for the conditions within the casings.

A suitable steel support is to be provided for each fan, and the frame is to be fabricated from rolled steel channel with adequate cross members for bolting the fan into position. The frame shall be of welded construction with anti-vibration mountings.

The anti-vibration mountings are to be rubber in shear pattern and of a type that are bolted to both the fan and the support.

8.0 PARTICULAR FAN

Inline Duct Mounted

Unit casing shall be manufactured in epoxy coated aluminium alloy and shall house twin fan assemblies, each comprising double inlet forward curved centrifugal impellers running in an individual scroll. Impellers may be either direct driven or belt driven depending upon the fan duty

Units shall be supplied for either roof mounting or plant room use as indicated on the drawings.

9.0 ELECTRIC MOTORS

Unless otherwise specified in the equipment specifications, all motors supplied and installed as a part of mechanical works shall conform to the following requirements:

Motors shall be of high efficiency, and shall be constructed and type. These shall be of totally enclosed fan cooled (TEFC) type to IP54 either with foot-mounting or flange-mounting suitable for its application. Unless otherwise specified, motors shall be designed for continuous running duty type S1 for operation during 3 years without maintenance. They shall be of such size as to drive adequately their associated equipment under the range of operating conditions, without overloading.

Windings shall be insulated with Class F insulation material to BS. 2757, and temperature rise of windings shall be class B (I.E. maximum of 80 deg.C. as measured by resistance method).

Electric motors up to and including 0.37 Kw shall be suitable for operation at 240 volts single phase. Motors rated above 0.37 Kw shall be of the 3-phase squirrel cage induction type with drip proof housing. Motors located directly in air streams shall be totally enclosed, fan cooled.

All the motors shall be provided with a substantial earthing terminal tapped into the frame or clamping device located on the cable end box side of the motor.

Terminal connections shall be constructed in such a way that direct contact between screws, bolts or nuts and the conductor is avoided.

The terminal box shall be of sturdy construction with ample space for connecting cables. An earthing bolt of adequate size shall be provided inside the terminal box for connecting to the cable earthing. This will be in addition to the earthing bolt provided in the motor enclosure. The terminal box shall be adequately weather proofed with a suitable non sticking reusable non-hygroscopic gasket material. These terminal boxes also shall be provided with suitable cable sealing end boxes or cable glands.

In addition to these items the following information shall be indicated:

1. Type of enclosure

b) Locked rotor torque on % of rated torque
   Locked rotor current in % of rated torque

b) Allowable running-up time in seconds (ART) bearing type, size, fit, re-greasing period and type of grease.

d) Net weight.
e) Purchase order number.

All motor shafts shall be provided with a key way unless the motor is of the flange mounted type in which case they shall be complete with adjustable rails.

The frame shall be painted in accordance with manufacturer's standards. However, the painting shall at least consist of one coat of primer and two coats of oil-resistant finishing paint.

10.0 MOTOR STARTERS, CONTROLS SWITCHGEAR

All starters and other control components shall be supplied and installed under this section but the contractor shall ensure that all components supplied shall comply with the requirements of the relevant sections of the electric specifications.

11.0 PANEL BOARDS AND MOTOR CONTROL CENTRE.

Construction of all panel board, motor control centres, control panels etc. shall comply with the relevant sections of the electrical specifications.

Air handling unit starter panels:

Each air-handling unit shall be supplied with a starter cubicle including the following:

a) A door interlocked isolator handle.

b) A three-position HAND/OFF/AUTO control switch.

c) A "motor run" lamp (green).

d) A "motor trip" lamp (red).

e) Motor speed selector switch

f) Motor starter assembly.

g) Control fuse.

h) Filter pressure drop (filter clog indication)

j) Inter-connection with fire alarm system and extract fans.

k) Power fuses with carriers and bases.

l) Moisture elimination heating coil.

m) Heating element contactors and controls.

n) Heating element 'energized' lamp (Green)

o) Heating element 'tripped' lamp (Red)

Note:
Control switch "Off" - Motor shall not run.
Control switch "Test" - Motor shall run except for local lock-off stop buttons.
Control switch "Auto" - Motor shall start and stop under dictation from remote control circuit.

Starter panels, where installed outdoor, shall be of the weatherproof type enclosure.

Fan Coil Unit Control Enclosure

Control components of each fan coil unit like contactors, transformers, controllers, etc. shall be
housed within an enclosure located besides the unit within the ceiling void.

Motor control centre shall be of the cubicle type, floor mounted and shall contain the following:

- Incoming as shown on the schematic diagram.
- Busbars for each phase, neutral and earth.
- Outgoing as shown on the schematic diagram.
- Starter as indicated on the schematic diagram.
- Pilot light for each phase.
- Pilot light for each motor in the plant room.
- On-off switch for each chiller control panel.
- Push button (start-stop) for each motor and plant room.
- One ammeter with selector switch for each motor in plant room.
- One ammeter for each phase for the incomer power supply.
- Voltmeter with selector switch.
- All required interlock wiring.
- Motor duty selector switch.
- Phase monitor relay for each motor.
- Low voltage protection device.
- Bank of capacitors for power factor improvement.
- Chiller sequence controls

Where motor control centres are installed outdoor, the panel shall be of the weatherproof type.

Motor control centre construction and components shall comply with the requirements as set out in the relevant sections of the electrical specifications.

12.0 SUBMISSIONS.

Initial technical submissions are to accompany the bid including full technical details of every item of equipment proposed for the project, with the appropriate figures and details highlighted in marker pen or similar in standard manufacturer's catalogues.

After final checking of sizing after award of contract, resubmission will be made with any changes specifically noted.

Technical submissions for the following are particularly required to be submitted.

- Chillers
- Air handling units.
- Fan coil units.
- Hi-Wall mounted A/c
- Pressurization Unit
- Motor Control Centre.
- Fans.
- Pumps

SIGNATURE OF TENDERER WITH SEAL  EMPLOYER
Chemical Treatment
Contractor has to conduct performance data & testing of unit computed at the site during commissioning & submit the same of all the unit

In the event that Consultant/Client requires further information on any of the proposed items the Contractor shall arrange visits to similar units, which he has installed. In any event, all equipment proposed for the project shall be currently installed and working satisfactorily locally. The Contractor must be able to provide references of at least three satisfied Owners and Consultant with equipment of the particular size and model proposed.

SECTION 5

DUCTWORK AND AIRSIDE EQUIPMENT

1.0 DUCTWORK MATERIAL.

1.1 Make all ductwork, unless specifically noted otherwise, of galvanized sheet steel conforming to ASTM A 525 or ASTM A 527, galvanized steel sheet, lock-forming quality, having zinc coating of 12.25 ounces per square foot for each side in conformance with ASTM A 90. The galvanizing shall be carefully done and the sheets shall be of such quality that they may be bent flat on themselves with no fracture to the coating or the base metal. All duct work, dampers and accessories shall be fabricated out of galvanized steel sheet manufactured to ISS: 277:2003. Duct shall be installed in a workman like manner, conforming to IS: 655-1963

All supports, stiffeners, flanges etc. used in ductwork construction and installation shall be hot dip galvanized. Ductwork guarantee shall cover workmanship, noise, chatter, whistling or vibration. Ductwork shall be free from pulsation under all conditions of operation.

2.0 DUCTWORK SPECIFICATION.

2.1 Ductwork fabrication / sheet metal ductwork material and installation shall comply with the latest edition of SMACNA Low Pressure Duct Construction Standards. Medium pressure round/oval double wall sheet metal ductwork shall comply with the latest edition of SMACNA High Pressure Duct Construction Standards. All air distribution devices (such as dampers) included in this specification shall comply with the latest applicable SMACNA manual and hanging methods shall be as described in the latest edition, and/or current edition of applicable manuals published by the Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA), where methods described in these volumes are not at variance with the requirements of any authority having jurisdiction, or do not conflict with methods described hereafter.

2.2 DEFINITIONS

A. Duct Size. The ducts sizes shown are inside clear dimension and do not include proper allowances for 1-inch acoustical lining, if required, and/or unless otherwise indicated.

B. Low Pressure Systems. Less than 3-inches w.g. to +3-inches w.g. positive static pressure and velocity less than 2500 fpm.

C. Medium Pressure System. 3 inches through 6 inches w.g. positive static pressure and velocities greater than 2000 fpm. (10.2 m/sec).

3.0 DUCTWORK GENERAL.

1.30 All dimensions shall be checked on site before ductwork manufacture is commenced.

1.31 Submit ductwork shop drawings and product data. Indicate duct fittings, particulars such as gages, sizes, weld and configuration prior to start of work for low, medium and high pressure and exhaust systems.

1.32 Erect all ducts in the general locations shown on the drawing(s), but conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor shall check the physical
conditions at the job site and make all necessary changes in cross sections, offsets and similar items, whether they are specifically indicated on drawings or not. Contractor to coordinate with all other services while installation of the ducting.

3.2. The whole of the ductwork installation shall be carried out by an approved specialist in ductwork manufacture and installation. No ductwork shall touch the building structure or building finishes direct, but shall be isolated with insulating spacer.

3.3. The fabrication shall be carried out in a neat and workmanlike manner with all ductwork true in size and cross-section, braced and stiffened as specified and with all internal and external surfaces free from projections and sharp edges.

3.4. At each main branch in ductwork and at each fan discharge and suction, provide sufficient number of Pitot tube test holes for balancing systems. Also provide test holes for traverse fan discharge and at all equipments. Test holes shall be located within easy reach of catwalks or ladder. Each test hole shall have 20 mm clear opening, provided with a metal ring plate with a threaded hole in the boss, and matching screwed head plug. Where these plugs are installed in insulated ductwork, provide an extension collar against which the insulation can be finished.

3.5. Ductwork shall be rigidly suspended or supported from building structure. Expansion type concrete inserts shall be placed so that the fastener is in shear rather than tension. Provide necessary steel angle iron required for bracing of ductwork or equipment, and for supporting ductwork from building structure. All supports shall be hot dip galvanized.

3.6. Increase in duct size shall be gradual. Where width or largest dimension of a duct is over 450 mm, duct shall be stiffened by bending in a break across corners in both directions. Ducts shall be self-supporting and complete in themselves. Visible internal portions of duct outlets to grilles and registers shall be painted in dull black.

3.7. All necessary allowances and provisions shall be made in the installation of the ducts for the structural framing of the building and when changes or offsets are necessary, the required cross-sectional areas shall be maintained. All of these changes however, shall be approved, and installed as directed at the time.

3.8. During installation the open ends of ducts shall be protected with blank, flanged sheet metal baffles, securely attached to prevent debris and dirt from entering.

3.9. Where ducts are shown connecting to masonry openings and/or along the edges of all plenums at floors, walls, etc., provide a continuous 30 x 30 x 4 mm galvanized angle iron which shall be bolted to the structure and made airtight to same by applying caulking compound on the angles before they are drawn down tight. The sheet metal at these locations shall be bolted to the angle iron framing.

3.10. All air ducts, casings, plenums etc., shall be constructed of lock forming quality prime galvanized steel sheets, which are free from blisters, slivers, pits, imperfectly coated spots etc. No second quality sheet metal allowed.

Where damage (or rusting) has occurred on galvanized duct work the affected section shall be made good by painting with two coats of zinc-rich paint and approved finishing paint, or where the damage in the Consultant's opinion cannot be made good, then a new section of ductwork shall be provided at no cost to the contract.

3.11. Duct shall be constructed using double or Pittsburgh lock corner seams. All seams shall be hammered down and made airtight by applying sealant before hammering down.

3.12. Support the vertical ducts installed in the various shafts at each floor level with galvanized supporting iron of approved size. Install these angles across the width of the shaft, with their ends attached to angle irons securely anchored into the masonry walls of the shaft, or attached to the framing of the floor openings. The ducts shall be bolted to these supporting angle irons.

3.13. Ensure that all openings required through floors, walls, partitions etc., for the duct system are provided in the exact location required.
3.14 Each piece of ductwork shall be wiped inside and out before installation and all open ends shall be capped and sealed to prevent entrance of dirt during construction. Ensure that ductwork systems are clean and free from dirt, dust, grime, debris etc., before initial operation of fans. Fans shall not be operated until the filters are installed and approval from the Consultant has been obtained.

3.15 All dusts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

4.0 LOW PRESSURE DUCTWORK.

4.1 This applies to ductwork with mean velocities less than 2,000 fpm (10 M/Sec) and static pressures of 2 inches water gauge, (500 pascals) or less.

4.2 Rectangular low-pressure ductwork shall be fabricated from prime quality, re-squared, tight coat galvanized steel sheets of the following gauges.

<table>
<thead>
<tr>
<th>Size of Duct (Milli metres)</th>
<th>Thickness</th>
<th>Bracing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GI Sheet Metal.</td>
<td></td>
</tr>
<tr>
<td>400 mm less in width/depth</td>
<td>0.63 mm</td>
<td>None</td>
</tr>
<tr>
<td>400 to 750 mm width/depth</td>
<td>0.63 mm</td>
<td>25x25x3mm angles</td>
</tr>
<tr>
<td>751 to 904 mm width/depth</td>
<td>0.80 mm</td>
<td>25x25x3 &amp; 40x40x3mm</td>
</tr>
<tr>
<td>905 to 1525 mm width/depth</td>
<td>0.80 mm</td>
<td>38x38x3.2mm diagonal</td>
</tr>
<tr>
<td>1525 to 2250 mm</td>
<td>1.00 mm</td>
<td>38x38x3.2mm diagonal</td>
</tr>
<tr>
<td>2250 mm and over</td>
<td>1.25 mm</td>
<td>40x40x3mm diagonal angles</td>
</tr>
</tbody>
</table>

4.3 Low pressure suction and discharge plenum chambers shall be fabricated from 1.25 mm (18 gauge) galvanized steel with galvanized angle iron framework and bracing.

4.4 Construct tees, bends and elbows with radius of not less than 1-1/2 times the width of duct on centerline. Rectangular 90-degree elbows shall be constructed with double-wall, airfoil, and galvanized sheet metal turning vanes. The turning vanes shall be fabricated in accordance with SMACNA HVAC Duct Construction Standards. Same applies to square elbows. Vanes shall be tack welded to vane rail. For vane lengths over 1000 mm, tack weld vanes to 10 mm tie-rod at mid-span.

4.4 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

5.0 ACCESS PANELS

1 Duct access panels shall be minimum 450 x 300 mm size, unless restricted by duct dimensions. All access panels shall be constructed from galvanized steel sheets, with necessary reinforcing inside for rigidity, with space filled with glass fiber insulation. Panels shall be made airtight with a continuous neoprene rubber gasket.

5.2 Apparatus access doors shall be minimum 600 x 1500 mm with angle or channel frame. Provide two 75 mm strap hinges with brass pins; and two handles minimum, operable from inside and outside. All access panels shall be constructed from double thickness 18 gauge (1.3 mm) galvanized steel, with 25 mm insulation between sides with necessary reinforcing for rigidity.

5.3 Provide access panels where shown, required and directed and in the following locations:
- Bottom of all duct risers.
- Next to outside air intakes and outlets.
- At each fire damper.
6.0 BALANCING DAMPERS. (VCD)

6.1 Install volume control dampers in accessible locations at all branch connections and wherever necessary to adjust the flow of air to secure correct distribution. Casing and blades shall be made of galvanized sheet metal, and shall be equipped with an approved device for fastening in any desired position. This device shall be such that the damper cannot move or rattle and pointer shall indicate the position of the damper from the outside of the finished duct insulation.

6.2 Volume control dampers of 1.2mm thick GSS blades, extended linkage rods for motorized operation, channels, flanges suitable for duct mounting and with a manual operating handle. Dampers shall be aerofoil multileaf opposed blade with blade height not more than 180 mm.

6.3 All blades shall be operated by a single operating with suitable link, livers and quadrant with gears and links as necessary. For their proper operating, control or setting devices shall be made robust, easy to operate and accessible.

6.4 The whole damper assembly shall be mounted in a galvanized frame with flanges.

6.5 Dampers shall be UL listed or certified by an equal regulatory authority.

7.0 VIBRATION ISOLATION (For all sections)

7.1 All plant and equipment shall be isolated from the building structure in such a manner that noise and vibration is not transmitted through the structure.

Anti-vibration equipment will be manufactured by a specialist company acceptable to the Consultant, and with standard ratings information available.

The following requirements are minimum requirements and must be confirmed by the specialist manufacturer's representative as being adequate for the particular equipment proposed by the Contractor.

7.2 In addition, Flexible connection shall be included at inlet and outlet to all items of equipment.

Flexible connections will be of full line size and will be flanged with gaskets and mating flanges.

Connectors shall be twin sphere manufactured with multiple ply's of nylon tire cord fabric and neoprene in hydraulic rubber presses and vulcanized.

8.0 DIFFUSERS AND REGISTERS

8.1 Supply and return air diffusers shall be shown on the drawing and indicated in schedule of quantities. Supply air Registers and diffusers to be of high quality Extruded Aluminum profiles, double deflection aerofoil blades with Aluminum profile with 20mm min spacing, nylon bushing and the damper frames and blades shall be high quality extruded Aluminum profile with natural aluminum finish. The supply air diffuser shall be provided with removal key operative volume control dampers. Diffusers, registers and grilles shall be arranged for flush mounting in lay-in type ceilings and over lap mounting in plaster, mineral tile and similar ceilings, with concealed fixings unless otherwise directed.

8.2 Grills shall be extruded aluminum construction. Grilles, register and diffuser locations shall be adjusted to suit reflected ceiling drawings, or Consultant's site instructions. All grilles, registers, diffusers, louvers shall be from one manufacturer.

8.3 Provide plaster frame for grilles, and diffusers installed in plaster ceilings.

8.4 All diffusers, grilles and registers shall be supplied completely factory powder coated. Finish colour shall be to the approval of the Architect. The interior of all grilles and diffusers is to be factory painted matt black.

8.5 All supply grilles and diffusers will have opposed blade-balancing dampers. All will have foam rubber sealing band around the edge to seal to the structure.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 373 of 494
3.16 Unless otherwise specified basic grilles and diffuser materials shall be Aluminum extruded sections. Sections in the airstreams shall be carefully selected to minimize turbulence.

8.7 All grilles and diffusers supplied on this project shall be tested and rated in accordance with ASHRAE Standard 70-72, ADC Test Code 1062-GRD and ISO 3741.

8.8 Ceiling Diffusers shall be multicone giving 4 way horizontal discharge

The three centre cones of the diffuser shall be manufactured from pressed aluminum, with the remaining cones and the outer frame fabricated from extruded aluminum welded at the corners to give near invisible joints.

4 way pattern cores shall be used as indicated on schedules. All cores shall be interchangeable.

The core shall be removable without the use of special tools, but for safety, shall be fixed to the outer frame by a small length of chain.

The diffuser shall be complete with an opposed blade damper painted matt black.

Wherever the air volume of supply / return air diffuser is not in proportion with the Standard size of the diffuser the overall size shall remain suitable for the longer airflow rate during the fabrication of diffusers. For lesser flow rate internal core / cores shall be blocked to achieve the require airflow with adequate throw and specified noise levels.

All such alterations shall be carried out by the manufacturer in the factory in such a way that specified air volume is maintained all the time without effecting the required throw for that particular diffuser. Noise levels shall not exceed specified limits in any case.

In general, sizes and air volume of all diffusers as shown on design drawings shall be maintained by achieving required throw and specified noise levels without effecting uniform air diffusion pattern.

Where a 4-way throw diffusers are installed very close to wall or obstruction, the diffuser shall be 4 ways, but with internally blocked in the area of obstruction.

9.0 SAND TRAP LOUVER FOR AIR INTAKE

9.1 Sand trap louvers shall have a double deflection inlet passage to separate sand from incoming air by means of centrifugal forces.

9.2 Separation efficiency particle size 350-700 shall not be less than 90% at a face velocity of 1M/Sec and not less than 70% at a face velocity of 2M/sec.

9.3 Sand trap louver shall be of aluminum construction, self-cleaning and maintenance free. The base of the louver shall have self-emptying sand holes.

9.4 Pressure drop at 2 M/Sec average face velocity shall not exceed 120 pascals.

9.5 Insect mesh shall be included.

9.6 Sand louvres shall be provided with powder-coated finish to the approval of the Architect.

10.0 FILTERS

10.1 Pre filters

Filter Media shall be of the non-woven cotton fabric type. The filter media shall have an average efficiency of 25-30% on ASHRAE Test Standard 52-76. It shall have an average arrestance of 90-92% in accordance with that test standard.

Media support Grid shall be a welded wire grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and
media pull away.

The media support grid shall be formed in such a manner that it affects a radial pleat design, allowing total use of filter media.

Enclosing frame shall be constructed of a rigid, heavy duty, high wet strength beverage board, with diagonal support members bonded to the air entering and air exiting side of each pleat, to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack, thus, eliminating the possibility of air bypass.

11.0 SUBMISSIONS

11.1 Technical Submissions

For any minor revisions in architectural layouts, contractor shall be responsible to carry out part redesign for such area and submit necessary calculations for Engineer's approval before proceeding with the shop drawings.

11.2 The Contractor will prepare full shop drawings, including sections, of distribution systems and equipment.

11.3 Hardware Submissions.

The Contractor will submit catalogue information for all distribution equipment including, but not limited to:

- Ductwork - Low pressure.
- Flexible ductwork - Low pressure
- Flexible connections.
- Access panels.
- Balancing dampers.
- Vibration isolators.
- Diffusers, grilles and registers.
- Louvers, Sand louvers.
- Filters.

11.4 The Contractor will submit samples for any or all of the above as requested by the Consultant after receipt of the catalogues.

11.5 Samples will definitely be required of these items, which are exposed, such as diffusers, grilles and louvers. The samples must be of size, specification and finish to be relevant to the project.

9.7.2 Where a Country of Origin is given, this refers to the Head Office in the case of International Corporations. However, for each product not manufactured in that Country, separate approval must be obtained from the Consultant/Client.

12. EXECUTION

12.01 INSTALLATION - SHEET METAL DUCTWORK: Duct shall be installed generally as per the drawing and in strict accordance with approved shop drawings to be approved by the contractor.

A. Construction Standards. Use construction methods, which follow the requirements outlined in SMACNA Balancing and Adjusting publications, unless indicated otherwise in these specifications or accompanying drawings.

1. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.

2. Plenum Construction. Construct single-wall and 2" (thick insulation double-wall) plenum chambers of 18G sheet metal reinforced with galvanized structural angles.
3. **Cross Breaking or Beading.** Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.

4. **Wall Penetrations.** Where ducts pass through walls in exposed areas, install suitable escutcheons made of sheet metal angles as closers. Support ducts where passing through floors with steel structural angles of adequate bearing surface, galvanized after fabrication and resting on top of the sleeve.

5. **Interior Painting.** Paint flat black, the interior of metal ductwork exposed to view through grilles, registers, and other openings. Do not install grilles, registers, or similar items until painting is complete.

6. **Ductwork Openings.** Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

   (i) **Ductwork Location.** Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

   (ii) **Sealant.** The entire duct system shall be sealed. Nonhardening, water resistant, fire resistive, compatible with mating materials; liquid used along or with tape, or heavy mastic. Duct shall be thoroughly cleaned prior to application of sealant. All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. All ductwork shall be sealed as per seal Class A irrespective of the duct pressure classifications.

   (iii) **Hangar Rod.** Galvanized steel, threaded continuously. (Refer Table)

   (iv) **Duct shall be straight be smooth on the inside neatly finished joints. All joints shall be made airtight.**

   (v) **Change in dimension and shape of ducts shall be gradual, cuved elbows, unless otherwise indicated, shall have a centerline radius equal to one and a half times the width of the duct. Air turns shall be installed in all vanes, arranges to permit the air to make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/proper air distribution.**

   (vi) **Duct shall be fabricated as per details shown on drawing. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of sample size to keep the ducts true shade and prevent hulking, vibration or breathing.**

12.02 **LOW PRESSURE DUCTWORK**

1. **Construction.** Construct rectangular ducts in accordance with the SMACNA Duct Manual.

2. **Controls.** For control devices concealed by ceilings, furring, or in other inaccessible locations, furnish extension rods and appropriate recessed-type regulators, mounted on the surface of the ceiling or the furring, unless specified, or shown otherwise. For ducts which are not concealed, or ducts that are above lay-in ceiling but accessible, provide heavy-duty, quadrant-type, adjustable regulators having wing nuts for locking in position. Saw-mark the ends of all operating rods for dampers and air control devices to indicate damper position.

3. **Obstruction.** Install streamlines deflectors at any point where dividing a sheet metal duct around piping or where other such obstruction is permitted. Where such obstructions occur in insulated ducts, fill space inside streamliner and around obstructions with glass fiber insulation.

4. **Low Pressure Duct Supports.**

Horizontal Ducts Up to 40 Inch. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 18 U.S. gage band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to supports with toggle bolts, beam clamps or other approved means. Place supports on at least 8'-0” centers. Use clamps to fasten hangers to reinforcing on sealed ducts.

Horizontal Ducts Larger Than 40 Inch. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Use double nuts and lock washers on threaded rod supports. Place supports on at least 8'-0” centers according to the following:
Angle Length | Angle | Rod Diameter
-------------|------|-------------
4'-0"        | 1-1/2"x1-1/2"x1/8" | 1/4"
6'-0"        | 1-1/2"x1-1/2"x1/8" | 1/4"
8'-0"        | 2"x2"x3/16" | 5/16"
10'-0"       | 2 1/2"x2 1/2"x3/16" | 3/8"

Vertical Ducts. Support vertical ducts where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60 inches. Above 60 inches, the angles must be increased in strength and sized on an individual basis considering space requirements.

7. MEDIUM PRESSURE DUCT SUPPORT SCHEDULE:

All horizontal rectangular ducts shall have duct hanger requirements as follows:

Minimum Hanger Size

<table>
<thead>
<tr>
<th>Max. Duct Dimen.</th>
<th>Steel Rod</th>
<th>Galv. Steel Strap Width</th>
<th>Max. Spacing</th>
<th>Min.# Hngrs</th>
<th>Trapeze Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 thru 18&quot;</td>
<td>--</td>
<td>1&quot; x 16 ga.</td>
<td>10'</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>19&quot; thru 36&quot;</td>
<td>--</td>
<td>1&quot; x 16 ga.</td>
<td>10'</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>37&quot; thru 60&quot;</td>
<td>3/8&quot;</td>
<td>1&quot; x 16 ga.</td>
<td>8'</td>
<td>2</td>
<td>2&quot; x 2&quot; x 1/4&quot;</td>
</tr>
<tr>
<td>61&quot; thru 120&quot;</td>
<td>3/8&quot;</td>
<td>1-1/2&quot; x 12 ga.</td>
<td>8'</td>
<td>2</td>
<td>2&quot; x 2&quot; x 1/4&quot;</td>
</tr>
<tr>
<td>121&quot; thru 240&quot;</td>
<td>3/8&quot;--4'</td>
<td>2-1/2&quot; x 2-1/2&quot; x 3/16&quot;</td>
<td>3</td>
<td>2-1/2&quot; x 2-1/2&quot; x 3/16&quot;</td>
<td></td>
</tr>
</tbody>
</table>

8. DUCT HANGERS - GENERAL NOTES (all pressures)

Hanger straps on duct width of 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the side.

Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8" bolts minimum.

Use 3/8" minimum bolts for securing duct hanger to band straps.

12.03 OPENING IN DUCTWORK

Provide opening in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

12.04 FLASHING

Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gage stainless steel or 16-ounce (450 g) copper.

12.05 DUCT LINING (LOW PRESSURE - RECTANGULAR)

Install glass fiber acoustical lining in all rectangular (except exhaust) ductwork shown on drawings. Provide Armaduct / Viodoflex / Phenotherm Eqvt acoustic line inside the ducts upto the initial 3 – 5 m of the supply ducts for air conditioning applications. Secure to duct surfaces with Foster 85-22 adhesive and sheet metal fasteners on 12-inch centers. Omit lining as necessary to permit satisfactory operation of air control devices. Coat all exposed edges and leading edges of cross joints with adhesive. Insulation shall not breed or promote fungi or bacteria, shall resist mold growth, shall not rot or sustain vermin.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
12.06 TESTS
Allowable Leakage. Test ductwork for leaks before concealing. Maximum allowable leakage is 5 percent of total flow.

Equipment: Provide equipment necessary for performing tests, including rotary blower, orifice section and U-tube gage board complete with cocks and rubber tubing.

Risers and Branch. Test duct riser or branch duct including flexible duct runouts in accordance with SMACNA manual.

Mains: Test mains after risers and branches are tied in and all equipment set. Close runout connections and place fan in operation. Provide pressure in mains above design pressure. Visually inspect joints. Repair leaks detected by sound or touch. Release mains for completion after joints are tight.

12.07 ADJUSTING AND CLEANING
Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

SECTION 6

FIRE DAMPER

A. Combination Fire/Smoke Dampers

1. Furnish and install where shown on the Drawings, or as required by the Specifications or BOQ combination fire/smoke dampers meeting the following requirements.

2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of ANSI-U L 555. The damper manufacturer shall have tested as per U L, a complete range of damper sizes covering all dampers required by this Specification. The leakage rating under UL555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gage pressure and 8 cfm per square foot at 4 inches water gage pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gage at the design air quantity. (Note that this may require a larger damper than the connected duct size.)

3. The damper frame shall be a minimum of 20 gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14 gauge equivalent thicknesses. The blade edge seal material shall be able to withstand 450 degrees F. The jam seals shall be flexible stainless steel compression type or lap seal type.

4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity, which meets all applicable UL555 and UL555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of 16 gauge where either dimension equals or exceeds 48 inches.

5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gage in the closed position, and 2500 fpm air velocity in the open position.

6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat/releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.
7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.

9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 6” W.G. static pressure.

10. All combination fire/smoke dampers shall comply with the specification as written above and shall be of Caryaire / Air master / George Rao make.

4. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape so as to allow for expansion and contraction of the sleeve and damper assembly.

5. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 8‖ wg for air flow in either direction.

6. In case of fire, the signal from smoke detector, mounted in housing having air sampling arrangement by means of air sampling tubes and filters, shall close the fire dampers as well as the Air handling unit.

C. Submittal and Installation

1. The air quantity and free area through each fire and combination fire and smoke damper has been noted on the drawing adjacent to the duct size or wall opening size where such damper is required.

2. Submittal(s) for fire and combination fire/smoke dampers shall include the following:
   a. Assign identification numbers for each damper with corresponding number noted on the drawings.
   b. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper.
   c. Provide manufacturer’s data of damper and its accessories or options.

3. One sample 18” x 12” damper shall be furnished for the purpose of illustrating damper operation to the owner's operating and maintenance personnel.

4. Access doors as specified elsewhere shall be provided to make all parts of the damper accessible. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

5. Contractor shall install each damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555.

6. After each combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to the installation of the ceilings, the Contractor shall, as directed by the Construction Inspector, activate part or all the dampers as required to verify "first-time" closure. Activation of the damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fusible link of the fire damper, and manually operating the fire/smoke damper through the pneumatic or electronic
controls as appropriate. Failure of the damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

SECTION 7

Duct Insulation

1.0 Insulation General.

1.1 The whole of the insulation work shall be carried out by an approved specialist insulation Contractor.

1.2 All allowances shall be included for informing the specialist contractor of all details of the building structure, programme arrangements, and other relevant details at the time of tender and for all necessary visits to site by the contractor or his workers.

1.3 The insulation material shall be elastomeric closed cell self adhesive nitrile rubber insulation (ARMAFLEX / KFLEX/SUPREME) with the following properties:

12 Density – 40 Kg / cum
13 Temperature Range: – 60 deg C to 105 Deg C
14 Ozone friendly ; no cracking; ASTM D 1171
15 Color : Grey / Black
16 Reaction to fire: Self Extinguishing
18 Health Resistance: Dust and Fibre free
19 Thermal conductivity () ASTM C 177
- Not greater than 0.036 W / mK at a mean temperature of 10º C
20 Vapour permeability
- 1.56 10-10 Kg/(m.hr.pa)
21 Fire rating
- Class 1 self extinguishing type

1.4 All material delivered to site shall be new and fully dried out and so maintained throughout the progress of the works.

All insulating materials shall be stored in storage sheds, and in accordance with the Manufacturer's recommendations.

1.5 In order to ensure that the insulation applied is in all respects in accordance with the specification, sections shall, as required by the Consultant, be cut from the finished insulation. If, however, defects are revealed, further sections shall be cut out for inspection, and all cutout sections shall be replaced at no cost to the Contract.

If further defects are revealed then the Consultant/Client shall have the right, when in his opinion it is necessary, to issue instructions for any part or the whole of the insulation to be removed and replaced. The replacement with new insulation shall be to the satisfaction of the Consultant and the cutting out and replacing shall be at no cost to the Contract.

1.6 Particular attention shall be paid to the finished appearance of all thermal insulation which must present a neat and symmetrical appearance running true in line with pipe layouts, etc.

1.7 Any rough, irregular and badly finished surfaces shall be stripped down and re-insulated to the Consultant's/Client satisfaction.

1.8 All systems are to have been tested and approved by the Consultant/Client prior to installation of
2.0 CONCEALED COLD AIR DUCTS.

2.1 Unless otherwise indicated insulate all ductwork (supply return, fresh air and extract) with 19mm thick elastomeric closed cell self-adhesive nitrile rubber insulation sheets. Cover the sections with vapour barrier of polythene sheet with minimum overlap of 75mm near the joints.

The insulation material to confirm to ASTM E 84.

3.0 EXPOSED COLD AIR DUCTS.

For ducts exposed in non air conditioned areas, insulate using the method described for concealed ducts, but using insulation with a minimum thickness of 40mm, elastomeric closed cell self adhesive nitrile rubber insulation (Armaflex / Kflex). And the finishes to be as mentioned in clause 2.1. Finally cover with 24 gauge aluminium sheet cladding.

Where ducts penetrate the building shell, the duct shall be flashed and waterproofed before any insulation is applied.

4.0 Condensate Drain Pipes and exposed cold water pipes on roof:

The pipework shall be insulated with 9mm thick elastomeric closed cell self-adhesive nitrile rubber.

5.0 LAGGING ADHESIVE

5.1 Adhesive shall be a flexible, fire resistive compound suitable for vapour sealing insulated ducts and pipes.

5.2 Adhesive shall be suitable for indoor and outdoor use and in high humidity environments.

6.0 ACOUSTIC INSULATION

6.1 All low-pressure ductwork shall be lined with acoustic insulation up to the first take off point, or 5 meters from the AHU outlet whichever is greater.

6.2 Duct acoustic lining shall be 9 mm thick, fiberglass, and 24 Kg/cum density with a thermal conductivity of 0.035 Watts/ M/ deg C with approved coating on inside.

6.3 Liner will be attached by a fire resistant adhesive such as Benjamin Foster 81-99, or equivalent. In addition mechanical fasteners shall be used on 400 mm centres on top and side sections. These fasteners must be spot-welded to the inside of the duct and must not perforate the duct. The insulation material shall be covered with 24 G perforated aluminium sheet.

7.0 ALUMINIUM CLADDING – FOR EXPOSED SURFACES

7.1 Aluminium cladding shall be provided to ducts with neat 90 degree joints and finish. Material shall be with stone finish.

7.2 In pipework the longitudinal joints shall be cleated or held in position with stainless steel bands and clips. Elbows and other fittings shall be made with mitred section and riveted. All valves strainers, flexible connection etc. shall have easy removable boxes with stainless steel aluminium toggle clips.

7.3 In ductwork the joints shall be riveted or banded with stainless steel band and clips to avoid sagging. Boxes to be made around duct traverse joints.

7.4 All gaps shall be to a minimum and shall be sealed with silicon mastic suitable for outdoor.

8.0 SAMPLES

8.1 Submit samples of all types of insulation for approval.
8.2 Submit with samples, the full technical brochures.

8.3 Where the specification calls for additional treatments, such as wrapping and waterproofing, submit also a completed sample of similar size.

1. All samples after approval are to be retained on site to be a reference for future work.

REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
E. ASTM E84 - Surface Burning Characteristics of Building Materials.
H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
I. UL 723 - Surface Burning Characteristics of Building Materials.

SUBMITTALS

A. Product Data: Provide product description, list of materials and thickness for each service, and locations.
B. Samples: Submit two samples of any representative size illustrating each insulation type.
C. Manufacturer's Installation Instructions: Indicate procedures, which ensure acceptable workmanship and installation standards will be achieved.

QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site in proper conditions as stated in Section 1.
B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.
C. Store insulation in original wrapping and protect from weather and construction traffic.
D. Protect insulation against dirt, water, chemical, and mechanical damage.

ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

**EXECUTION:**

**EXAMINATION**

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

**INSTALLATION**

Install materials in accordance with manufacturer's instructions.

All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of duct/pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 15A.

Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied three (3) to a section of pipe. Fittings, valves, etc., shall have bands on each side.

For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer’s recommendations.

**TOLERANCE**

Substituted insulation materials shall provide thermal resistance within 5-10 percent at normal conditions, as materials indicated.

**SECTION 8**

**MEASUREMENTS**

The following procedure for measurement shall be followed for purpose of billing in case of items subject to variation in quantities.
10 Ducting:

13.2 Payment for ducting shall be on the basis of the external surface area of the ducting including all material and labour for installed duct.

13.3 The rate per square meter of the external surface shall include all wastage flanges, flanges, gaskets for joints, bolts and nuts, duct supports and hangers, vibration isolation pads or suspenders, flexible connections, inspection doors, dampers, turning vanes, straightening vanes, and any other item which will be required to complete the duct installation except external insulation and finish thereon.

13.3.1 The external area shall be calculated by measuring the over all width and depth (including the corner joints) in the center of the duct section and over-all length of each duct section from flange face to flange face in case of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

13.3.2 In case of taper pieces average width and depth will be worked out as follows

\[
\begin{align*}
W_1 &= \text{Width of small cross section} \\
W_2 &= \text{Width of large cross section} \\
D_1 &= \text{Depth of small cross section} \\
D_2 &= \text{Depth of large cross section} \\
\text{Average Width} &= \frac{W_1 + W_2}{2} \\
\text{Average Depth} &= \frac{D_1 + D_2}{2}
\end{align*}
\]

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct / sections fitted with angle iron flanges; otherwise at the bottom of the flange where the flanges are of GSS. Face to face length for taper piece shall be the mean of the lengths measured face to face from the center of width and depth flanges.

13.3.3 For Circular pieces the diameter of the section midway between large and small diameter shall be measured and adopted as the mean diameter for calculating the surface area off the taper piece. Duct measurement for calculation of area shall be taken before application of insulation.

13.3.4 For special pieces like bends, branches, and tees, etc., the same principal of area measurement as for linear lengths shall be adopted, except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along the curvature of angle of the piece.

11 Grill/Diffuser:

Payment for grill/diffuser shall be on the basis of internal (effective) surface area of the grill/diffuser including all material and labour for installed grill/diffuser. The rate per Sq. meter of surface shall include all flanges, gaskets, bolts and nuts etc. The internal area shall be calculated by measuring the liner width and depth of the grill.

12 Piping

Piping shall be measured in unit of length along the center line of installed pipe including all pipe fitting, flanges (with gasket and nut and bolts for jointing), union bends, elbos, tees, concentric and eccentric reducers, inspection pieces expansion loop etc. The above accessories shall be measured as part of piping length along the center line of installed pipes and no special rates for these accessories shall be permitted. The quoted rates for center line linear measurements of piping shall include all wastage, allowance, pipe supports including hanger, MS channel, vibration isolators suspension where specified or required.

13 Piping Insulation

Piping insulation shall be measured in unit length along the centerline of the installed pipe, strictly on the same basis as the piping measurements described above. The linear measurement shall be taken before the application of the insulation.
14 Duct insulation/Acoustic lining

This item is provided separately for various thickness and shall be paid for on an area basis of un-insulated duct. The area of the duct to be insulated shall be measured before application of insulation.

The Owners/Consultants shall have the right to reject all supplies, which do not conform to the samples so approved.

2.0 The insulation shall be applied as under:

(i) Clean the duct surface to be insulated free from dust, grease & other dirt.

(ii) Measure the size of the duct and cut the insulation sheet to the required size with a sharp knife and straight edge. Remove the sheet from the role and fix it to the duct and apply slight pressure so that it bonds well. Ensure that sheet is in desired position before the adhesive of the sheet makes contact with the sheet metal duct.

(iii) Seat the joints using black adhesive tapes as per recommendations of the manufacturer.

SECTION 9

CHILLED / CONDENSER WATER PIPEWORK

1.0 PIPEWORK MATERIAL GENERAL

11 All pipework shall be free from surface or general corrosion and without any signs of scaling, pitting or excess weathering. Any pipework so affected shall be replaced at no cost to the contract.

Each length of pipework shall have at least one coloured identification band or identifying mark, when delivered. All pipework shall be supplied in the manufacturer's straight random lengths.

All plain mild steel pipework shall be supplied self-coloured and externally varnished.

1.2 Chilled Water/Condenser/Hot water Service Pipework.

1.3 All pipework and fitting shall be ERW of MS Class “C” (heavy class) confirming to BIS 1239 and 3589. All the joints in the piping system shall be done by welding.

1.4 Condensate Drain Pipework.

All condensate drain piping shall be GI with Insulation and HDPE as mentioned in schedules.

1.5 All pipework, pipework fittings, jointing materials and gaskets shall be stacked in storage sheds in accordance with the manufacturer's recommendations and as required elsewhere in this specification. The ends of all pipework shall be protected during transit and storage.

1.6.1 Metal pipework may be stacked in the open, provided that such stacks are, in the Consultant's opinion, adequately protected from weathering. The pipework shall be located in steel pipe racks and clear of the floor; the floor being formed from either creosoted timber sleepers or paving slabs.

1.6.2 All piping shall be black steel unless otherwise stated. Pipes shall be given one primary coat of re-oxide paint before being installed. Pipes shall be sloping towards drain points.

1.6.3 Fittings shall be new, fitting used on welded piping shall be malleable casting of pressure rating for the piping system. Fitting used on welded piping shall be of the weldable type. Supply of flanges shall be include bolts, washer gasket, etc as required.

1.6.4 All equipment and valve connections shall be through flanges (welded or screwed) for galvanized steel.

1.6.5 Sufficient number of flanges and union shall be provided.

2.0 PIPE INSTALLATION GENERAL

21 All pipework shall be arranged to set round piers and other obstructions and minor modifications shall be made as required by the Consultant to circumvent site difficulties.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
2.2 Pipe shall be arranged to follow the contour of walls or beams or other building structure lines and all vertical pipework shall be plumb, without offsets and set as close as possible to any local projections consistent with maintaining adequate clearances for installation of wall plates or insulation.

2.3 Pipework shall be installed so as to give the following minimum clearances between the pipe (or pipe insulation where specified) and adjacent surfaces as follows:-

<table>
<thead>
<tr>
<th>Surface Description</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>25 mm</td>
</tr>
<tr>
<td>Ceilings</td>
<td>50 mm</td>
</tr>
<tr>
<td>Finished floors; either: above top of skirting</td>
<td>50 mm</td>
</tr>
<tr>
<td>or (if greater)</td>
<td>150 mm</td>
</tr>
<tr>
<td>Adjacent pipes, both insulated</td>
<td>25 mm</td>
</tr>
<tr>
<td>Adjacent pipes in trench, both insulated</td>
<td>100 mm</td>
</tr>
<tr>
<td>Adjacent pipes, both uninsulated</td>
<td>150 mm</td>
</tr>
<tr>
<td>Adjacent pipes, one insulated</td>
<td>75 mm</td>
</tr>
<tr>
<td>Insulated pipes to adjacent conduit</td>
<td>100 mm</td>
</tr>
<tr>
<td>or trunking</td>
<td></td>
</tr>
<tr>
<td>Adjacent electrical cables not in conduit or trunking</td>
<td>150 mm</td>
</tr>
</tbody>
</table>

Notwithstanding the above minimum clearances, sufficient space shall be allowed to facilitate easy application of insulating materials. Pipes shall not be enclosed in a common insulating covering.

2.4 Pipework shall be graded to ensure adequate draining and venting. Draining and venting facilities as detailed in the particular specification for individual services shall be fitted at all low and high points respectively and wherever else necessary to ensure that all sections and subsidiary sections can be drained and that no air locks can form.

2.5 The Consultant/Client may at his discretion ask for the removal of installed pipework for examination. No extra payment will be made when such removal is called for.

If the pipework is found to have been installed in an unsatisfactory manner, then the complete installation shall be thoroughly inspected and all unsatisfactory sections shall be removed and re-fixed in a proper manner.

2.6 During constructional work on all pipework services, care shall be taken to prevent any foreign matter entering the pipework. All open ends shall be capped with the appropriate pipework fittings. Wooden plugs and the like shall not be used. Valves fitted on the ends of pipework shall not be accepted as a means of preventing the ingress of foreign materials.

2.7 Failure to comply with these requirements shall mean that the Consultant/Client shall have the right to instruct that pipework so left uncovered to be dismantled for such lengths as the Consultant requests, and the pipework blown through and/or cleaned at no cost to the contract.

2.8 All pipework fittings shall be installed in such a manner to ensure that air cannot be trapped and that pipework can be drained.

2.9 Where fittings are connected to light or medium weight pipework they shall be 'medium' quality, and where connected to heavyweight pipework they shall be 'heavy' quality.

2.10 All fittings, valves, cocks etc., shall be manufactured from materials guaranteed proof against de-zincification unless specifically stated otherwise elsewhere.

2.11 Reducers on all vertical pipework shall be concentric. In all other positions eccentric reducers shall be fitted in a manner to maintain a level bottom and ensure that fluids are not collected at that point in the system. Where it is not possible to fit eccentric reducers the Consultant's approval shall be obtained before fitting concentric reducers. Reductions in all cases shall be made by the use of factory made fittings.

2.12 All branches shall be made by easy sweep tees, twin elbows. Bends shall be used wherever possible. All sweep fittings and all sweep bends shall be of the long radius pattern except where the use of these fittings would stand pipework too far from wall surfaces and make for unsightly appearance, in which
case short sweep tees and elbows may be used provided that the Consultant's written approval is obtained beforehand.

1. PIPEWORK INSTALLATION.

31 Welded Joints.

Welding shall generally be in accordance with the relevant Section of the General Specification.

All steel elbows shall be of long radius pattern except where space conditions do not permit. The substitutions of short radius elbows must be approved by the Consultant.

32 Welding Piping:

3.2.1 The ends of pipe lengths to be welded shall be cut square by saw or cutter and the edges beveled to form a ‘V’ groove before welding. Under no circumstances, shall gas cutting form the edges.

3.2.2 Weld metal is to be thoroughly fused with base metal at all sections. Welds shall be of sound metal, free from laps, slag inclusion or other defects.

3.2.3 All welders shall be certified by the Consultant/Client for the service for which they are employed and on which they work.

3.2.4 Wherever welded piping connections to equipment, valves, or other units need maintenance, servicing, or require possible removal, the connection joint shall be flanged. Pressure rating of the pipe flanges shall match the pressure rating of the flanges on the equipment to which the piping connects.

4.0 PIPEWORK SUPPORTS

4.1 All pipework shall be adequately supported. All support installations shall be in accordance with relevant British Standard Specifications and Codes of Practice, except where modified or extended by the contract documents.

4.2 Supports shall allow free movement for expansion or contraction of pipework and shall be located to ensure that pipework branches or fittings are not fouled by the support during expansion or contraction of the pipework service.

4.3 Double banking of pipework from a single support position will be permitted, provided the normal operating temperature of the fluids in the two pipes do not differ by more than 30 degrees C., but only where space restrictions prohibit individual support. Triple banking will not be permitted.

4.4 Where double banking is necessary, the larger of the two pipes shall be uppermost, and where pipes are the same size but manufactured from different materials, then the pipe having the material with the lowest coefficient of expansion shall be uppermost. Support intervals for double-banked pipework of different sizes shall relate to the smaller size.

4.5 Vertical rising pipes shall be supported at the base and the support shall withstand the total weight of the pipe and fluid contained.

4.6 Supports shall not be permitted which clamp the pipe so that it is in contact with building fabric or structure.

4.7 All supports shall be specifically designed for the outside diameter of the pipe concerned (including specified packings). Oversized brackets will be rejected.

4.8 All pipework shall be supported in accordance with the following table:-
<table>
<thead>
<tr>
<th>Pipe Size (mm)</th>
<th>Horizontal Piping (Meters)</th>
<th>Vertical Piping (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steel</td>
<td>Copper</td>
</tr>
<tr>
<td>15</td>
<td>2.1</td>
<td>1.5</td>
</tr>
<tr>
<td>20</td>
<td>2.1</td>
<td>1.5</td>
</tr>
<tr>
<td>25-32</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>40</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>50</td>
<td>3.0</td>
<td>2.4</td>
</tr>
<tr>
<td>65</td>
<td>3.3</td>
<td>2.7</td>
</tr>
<tr>
<td>80</td>
<td>3.7</td>
<td>3.0</td>
</tr>
<tr>
<td>100-125</td>
<td>4.0</td>
<td>3.7</td>
</tr>
<tr>
<td>150</td>
<td>5.2</td>
<td>4.0</td>
</tr>
<tr>
<td>200</td>
<td>5.5</td>
<td>5.0</td>
</tr>
<tr>
<td>250</td>
<td>6.0</td>
<td>5.5</td>
</tr>
<tr>
<td>300</td>
<td>7.0</td>
<td>6.0</td>
</tr>
<tr>
<td>350</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>450</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>9.0</td>
<td></td>
</tr>
</tbody>
</table>

a) Spacing does not apply where span calculations are made or where concentrated loads are placed between supports, such as flanges, valves, specialties, etc.

b) All spacing length are in metre.

4.9 Vertical steel pipework shall be provided with pipe alignment as recommended by supplier and with pipe anchors at locations as agreed with the Engineer.

4.10 All chilled water pipe supports shall be galvanized.

4.11 All chilled water pipework services shall be supported around the insulation and not directly around the pipework. Care shall be taken to ensure the integrity of vapour sealing is not damaged in any way.

4.12 It shall be noted that in certain cases it will be necessary to adopt a combination of the support methods indicated, and when supports are required to be detailed to suit special site conditions or requirements, then these details shall be submitted to the Consultant for approval. Anti-vibration supports shall be fitted at all locations where pipework vibration is likely to be a problem.

5.0 VALVES.

5.1 Valves shall be provided and installed where required for the purpose of circulation control and isolation. Valves shall be of full bore size to suit the mains into which they are installed.

5.2 All castings shall be clean close-grained metal, free from rough projections. Screwed valves shall have heavy hexagon reinforcement threads, ample length threads and heavy shoulder to prevent over entry of pipes. Flanged valves shall have the flanges flat faced and of thickness conforming to the

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

Page 388 of 494
appropriate specifications for the respective services and drilled off-centre.

5.3 Valves shall have pressure rating as necessary for the service indicated on the drawing. Samples must be provided for inspection of the manufacturing methods.

5.4 Gate valves for sizes up to 50 mm, shall be bronze, on rising stem, screwed bonnet, one piece wedge. The stem shall have a lockshield to restrict unauthorized adjustment.

The casting shall have large hexagon section at all threads to permit gripping to prevent line distortion during installation.

Pressure rating shall be 16 bar.

5.5 Gate valves sizes 65mm dia and above shall be one piece butterfly valves, cast iron body, tapped, full lug body, 16 bar rated, 316 S / S shaft, aluminium bronze disc, EPDM seat extended onto flange face.

Valves on pipe connection to chiller condenser & pump shall be rated for 20 bar.

5.6 Globe valves size 50mm dia and below shall be bronze, rising stem, screwed bonnet and renewable dynamic disk.

5.7 Globe valves 65 mm and up shall be cast iron body valves rated for 16 bar, with outside screw and yoke, bolted bonnet, guide feature for disc seating.

5.8 Check valves up to size 50 mm shall be bronze, screwed ends, “Y” pattern with screwed access cap, regrindable seating, positive seating two piece swivel disc, rated at 16 bar.

5.9 Check valves size 65 mm to 100mm shall be cast iron body with bronze trim, 16 bar. rated, rotating disc with flexible hinge assembly, bolted access.

Check valves above 100mm shall be cast iron body, silent check, globe style, spring actuated, renewable seats, stainless steel disc, rated for 16 bars.

Check valves on condenser pumps shall be rated for 20 bars.

5.10 Control Valves (double regulating) upto size 50mm dia shall be of bronze body/brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential pressure readout ports across valve seat area. Read out ports to be fitted with internal EPT insert and check valve. Valve bodies to have 6MM NPT tapped drain/purge port. Valves to have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position.

All valves to have calibrated nameplate to assure specific valve setting. Valves to be leak tight at full rated working pressure. All valves to be provided with moulded insulation to permit access for balance and read out.

5.11 Balancing valves (double regulating) size 65mm dia and above shall be of heavy duty cast iron flanged construction with 1 25psi ANSI flanged connections suitable up to 175 psi working pressure.

Valves on pipe connection to chiller condenser and condenser pumps shall be 20 bar rated.

5.12 Balancing flow control valves (Motorised valve) – upto 300mm.


2. Valve size: shall be equal to full line size, as indicated on drawings.
3. Construction: Cast iron bodies, stainless steel stem and seat, enc plated plug.

4. 16 bar rated flanged.

5. All valves shall come with handwheel operator, calibrated flow setting scale, and pressure taps.

5.13 All valves shall be rated for a working pressure of 16 Bar, unless otherwise indicated.

5.14 In lieu of gate valves, butterfly valves may be used. Valves construction shall be ductile iron body, ductile iron disc, rubber encapsulated suited for the intended service. Valves shall be bubble tight, rated for 300 PSI with memory stop.

5.15 Certificate of Origin shall be provided for all valves.

6.0 STRAINERS.

Strainers shall be full line size located ahead of all pumps and in locations as indicated on drawings rated for 16 bar. Bodies shall be cast iron, screwed body, "Y" type, up to 50 mm size with 37% open mesh bronze metal screen, and 3 mm diameter holes.

For sizes 65 MM and above, Iron body, flanged, "Y" type bolted cover flange, tapped blow-off outlet, 37% open mesh bronze metal screen, with 3 mm diameter holes.

Strainer on condenser pump suction shall be rated for 20 bar.

7.0 GAUGES AND ACCESSORIES.

7.1 Wet service thermometers shall be straight shank mercury fill insertion type. They shall have a stem length of 80 mm and a scale length of 225 mm, and the capability of adjusting the angle of the scale to the stem. Provide copper or brass separable wells for each thermometer.

7.2 Air service thermometers shall be straight shank mercury fill insertion type. They shall have a stem length of 150 mm and a scale length of 225 mm, and the capability of adjusting the angle of the scale to the stem.

7.3 Pressure gauges shall have 100 mm diameter cast Aluminium case, black figures, forged brass sockets with phosphor bronze bushed rotary type movement and Bourdon tube. Gauges shall be complete with impulse dampening insert and T-handle gauge cock.

7.4 Range of gauges shall be selected such that the operating point is almost midway of the selected range.

8.0 AIR VENTS

8.1 Provide air vents at all high points in supply and return piping.

8.2 Automatic air vents shall have gunmetal or brass bodies, non-ferrous or stainless steel floats and guides and non corrodible valves and seats. Each automatic air vent shall be controlled by a lock shield valve. Air release pipes shall be run to discharge at the nearest visible point - to be agreed with the Engineer.

9.0 FLOW SWITCHES

9.1 Flow switches shall be provided at the outlet connection to each chiller.

9.2 Flow switches shall be paddle type with bronze construction for all parts in contact with water.

(k) FLOW MEASUREMENTS.
10.1 Provide in the main incoming supply line a feature to enable flow measurements to be made. Provide all equipment and, if indirect measurements are used, provide all calibration equipment, charts etc.

10.2 Provide water meter to monitor the quantity of water being added to the system by the make-up unit.

11.0 EXPANSION PROVISIONS AND ANCHOR POINTS.

11.1 All sections of pipework installations shall be installed in such a manner as to allow expansion and contraction for the pipework, without causing undue stress in any part of the installation.

11.2 Wherever possible expansion and contraction shall be absorbed by natural offsets and changes in direction of pipe runs. Provide anchors, pipe guides and expansion loops where shown or required, to the Consultant's approval. Do not use screwed fittings on expansion loops.

11.3 Connections to items of plant and equipment shall be made so that no stress is placed on the equipment or its' connections. All expansion devices shall be carefully erected in full accordance with the manufacturer's recommendation and instructions, and be approved by the manufacturer for the particular application concerned.

11.4 No system of expansion control shall be accepted where the closure of movement exceeds the amount recommended by the manufacturer when operating from the cold to the upper limit working temperature. The minimum temperature difference for calculation purpose shall be 40 degrees C for interior pipes, and 50 degrees C for exposed or external runs.

11.5 All expansion devices shall be cold drawn by a distance equal to half the total expansion and all contraction devices shall be cold compressed by a distance equal to half the total contraction.

11.6 All anchor points shall be treated as main anchor points, the practice of utilizing a less substantial anchor for "intermediate positions" shall not be permitted.

11.7 Where the installation is required to be tested in sections, extra anchor points shall be installed where necessary, for the protection of the expansion devices.

12.0 WATER SYSTEM TREATMENT (CLEANING)

12.1 The chilled water system shall be prepared as detailed elsewhere herein. The system will then be further treated.

12.2 Prior to testing and commissioning, the consultant shall be provided with water conditioning programme, to control water quality. Cleaning shall be supervised, and programme of conditioning administered by the conditioning company.

12.3 For Precommission cleaning, the system shall be dosed with the prescribed amount of the non acid cleaning agent and a surfactant as advised by the chemical company.

12.4 Cleaner shall be run into the system and retained for a period of 72 hrs. or more as advised by the chemical company. At the end of this period the system shall be drained and flushed with clean water.

12.5 All strainers and trapping points shall be inspected, and any debris removed.

12.6 System shall be refilled with clean water, re-circulated or run through for a further four hours, and again drained and flushed. The flushing shall continue till the effluent is clear, colourless, odourless, free from suspended solids and such that the iron level is not more than 10 ppm.

12.7 Upon completion of flushing all strainers shall be inspected and any debris removed.

12.8 The system shall be refilled with clean water and a specified amount of inhibitor added.

12.9 The Chemical Company representative shall conduct an analysis of the system's water after the cleaning operation, and shall submit a report to the Consultant.
Note: The HVAC Contractor shall advise on the holding capacity of the systems to be cleaned to
the Chemical Company, in order that the amount of cleaner required may be calculated.

13.0 START UP CHEMICALS.

13.1 The supply of all chemicals for system startup shall be the scope of this contract. Chemicals
sufficient for contractual maintenance period shall be arranged by the Contractor.

14.0 VIBRATION ISOLATION.

See Ductwork Specification.

15.0 PRESSURE TESTS.

See relevant sections of the General requirements.

16.0 WELDING TESTS.

See relevant sections of the General requirements.

17.0 SUBMITTALS.

17.1 Technical submissions are to include the schematic for components actually to be installed
showing flow rates, and accompanied by pressure drop calculation for the system.

17.2 Technical brochures and information on all components:

- Pipework, Pipe fittings, Pipe supports, Valves, Strainers, Gauges and accessories, Air vents.
- Flow measuring instruments.

17.3 In the event that the Consultant/Client requires further information on any item, samples must be
provided as necessary.

SECTION 10

PIPING INSULATION

PART 1 GENERAL

1.01. SECTION INCLUDES

A. Piping insulation.
B. Jackets and accessories.

1.02. REFERENCES STANDARDS

ASTM.
NFPA
UL

1.03 SUBMITTALS

A. As mentioned in our general requirements

B. Product Data: Provide product description, list of materials ‘k’ value, ‘R’ value, mean temperature
rating, and thickness for each service, and locations.
C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.04. QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

1. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

C. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.

E. No insulation shall be applied on pipes until the pipes are satisfactorily tested.

1.05. QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years experience specializing in the trade.

1.06. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site as instructed in Section 1.

B. Deliver materials to site in original factory packaging, labeled with manufacturer’s identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.07. ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.
C All insulation materials to be asbestos free.

PART 2 PRODUCTS

CHILLED WATER PIPING - TUNNELS AND BUILDINGS:

The Chilled water piping material shall be closed Cell Elastomeric Rubber Insulation with the following properties – Density of Material shall be between 40 to 60 Kg/m3; Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/mK at an average temperature of 0°C; the insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990; Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or ‘µ’ value should be minimum 7000.

Thickness of the insulation shall be as specified herein: All chilled water, refrigerant, and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. Contractor to fulfill the requirements related to the painting if any. All MS pipes shall be provided with a coat of zinc chromate primer. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

<table>
<thead>
<tr>
<th>Pipe nominal bore</th>
<th>Thk. For non-coastal places</th>
<th>Thk. For coastal places</th>
</tr>
</thead>
<tbody>
<tr>
<td>15mm - 25mm</td>
<td>19mm</td>
<td>25mm</td>
</tr>
<tr>
<td>32mm 80mm</td>
<td>25mm</td>
<td>32mm</td>
</tr>
<tr>
<td>100mm - 400mm</td>
<td>32mm</td>
<td>38mm</td>
</tr>
<tr>
<td>Above 400mm</td>
<td>45mm</td>
<td>45mm</td>
</tr>
</tbody>
</table>

Insulating material in tube form shall be sleeved on the pipes. On piping, slit opened tube from insulating material shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheets shall be used it shall be cut out in correct dimension using correct tools. Scissors or Hacksaw-blade shall not be allowed. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. All longitudinal and transverse joints shall be sealed by providing 6 mm thick, 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

To provide mechanical strength and protection from damage all pipe / duct insulated with nitrile rubber as indicated in BOQ shall be covered with self-adhesive fiberglass fabric of weight 200 GSM (grams per mtr2) and thickness 7 mil. Insulated pipes & ducts exposed to UV rays shall be covered with self adhesive fiberglass fabric of weight 200 GSM, and thickness 7 mil. Application procedure: Spread the self adhesive fiberglass sheet (with minimum overlap of 1 inch at joints) on insulation. Taking due care so as not to form any wrinkles on the surface.

No chilled water pipe supporting structures shall pierce the insulation except as anchor points as shown on the Drawings. At these points, the anchor member shall occur on the bottom of the piping to allow condensation to drain.

CONDENSATE DRAIN AND WATER RECOVERY (Fin Water) PIPING:

Condensate drain piping from fan and coil units, coil banks, drinking fountain refrigeration units, and other items of piping or equipment subject to condensation forming on the surface shall be insulated with a closed cell elastomeric thermal insulation as detailed in “Piping insulation”. Drain piping from mechanical rooms, and other areas potentially receiving chilled water or condensate from air handlers, shall be similarly insulated for a minimum of 15 feet.

PROTECTIVE JACKETING – CHILLER PLANT ROOM
Aluminum 26 G Jacketing and fitting covers shall be 26G aluminum smooth and pleasing appearance. The jacket shall be pre-cut, pre-rolled, and lapped a minimum of two inches (2") in all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.) 3/4" wide .020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016" aluminum or stainless steel with a smooth finish.

PUMPS:

The chilled water pump and hot water pumps shall not be insulated but the insulation of the connecting piping shall be continued up to the face of the flanges on the piping connection to the pump and any bare metal that projects over the bed plate of the pump and from which condensation might drip onto the floor.

Jacket material stapled in place and sealed with adhesive. Thickness shall be as scheduled.

ADHESIVE:

The Adhesive used for the piping, pumps and all other accessories shall be as recommended by manufacturer. The contractor shall NOT use adhesive without proper approval of the consultant/Client.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions in the absence of specific instruction herein.
B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the “90°” position, with the seam lapped such that the lap is directed down.
C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature: Vapor barriers are required. The vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
   1. Provide vapor barrier jackets, factory applied or field applied.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
   3. Finish with glass cloth and vapor barrier adhesive.
D. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
E. For insulated pipes conveying fluids above ambient temperature:
   a) Provide standard jackets, with or without vapor barrier, factory applied or field applied.
   b) Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
F. If PVC fitting covers are used they shall have 25/50 rating.
G. For hot piping conveying fluids 140F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

H. For hot piping conveying fluids over 140F insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union. See 2.04K.

3.03 INSERTS, SUPPORTS and SHIELDS:

A. Application: Piping 2 inches diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for insulated pipes 2" and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

<table>
<thead>
<tr>
<th>Lengths</th>
<th>Nominal IPS</th>
<th>Metal Thickness of Shield</th>
</tr>
</thead>
<tbody>
<tr>
<td>up thru 2&quot;</td>
<td>14 gauge</td>
<td>12&quot;</td>
</tr>
<tr>
<td>thru 6&quot;</td>
<td>12 gauge</td>
<td>16&quot;</td>
</tr>
<tr>
<td>and above</td>
<td>10 gauge</td>
<td>20&quot;</td>
</tr>
</tbody>
</table>

2 Insert Location: Between support shield and piping and under the finish jacket.

3 Insert Configuration: Minimum 2" inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

4 Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

5 The shields at support points shall be secured with 1/2" x 0.016" stainless steel bands and seals.

6 Finish insulation at supports, protrusions, and interruptions.

7 The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings.

8 In lieu of the above the following system of support may be used:

(vii) At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft³ Koolphen K Phenolic Foam material to withstand the bearing loads transmitted from the pipe to the support, it shall extend for at least 1" on either side of the support to allow sealing of the joints with the pipe insulation jacket.

(viii) The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table 1.

Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1" thickness of 2.2 lbs/ft³ standard insulation including FSK/ASJ vapor barrier.

Table 1 K Block Support Centers

| Nominal Pipe Size | 3/4 | 1 | 2 | 2 | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
|-------------------|-----|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
|                   | 1/4 | 1/2|   |   |   |   |   |   |    |    |    |    |    |    |    |

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Max support centers (feet) 
Sch 80 pipe filled with water covered with 1" of Standard Insulation

<table>
<thead>
<tr>
<th>Size</th>
<th>6.5</th>
<th>6.5</th>
<th>6.5</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>10</th>
<th>14</th>
<th>14</th>
<th>14</th>
<th>20</th>
<th>20</th>
<th>20</th>
<th>20</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Saddle Gauge (Galvanized Steel)</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>16</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>114</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Length of K Block (inches)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

For purpose of definition in this Specification: “concealed” areas are those areas which cannot be seen by the building occupants, and “exposed” areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.

Special Protection: All insulated piping in the mechanical rooms within 8’-0” of the floor shall be encased in a protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

All exposed outdoor piping shall have metal jacket.

Insulation ‘R’ Value Schedule \( (R = \text{thickness} / k) \) FPS

<table>
<thead>
<tr>
<th>Oper Service F</th>
<th>Temp</th>
<th>k @ Mean F</th>
<th>Min. R value for each P</th>
<th>1”</th>
<th>1-1/4”</th>
<th>4”</th>
<th>2-1/2”</th>
<th>5” &amp; er</th>
<th>8” &amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold(6) 40-55</td>
<td>.25 @ 75</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold(7) below 40</td>
<td>.25 @ 75</td>
<td>4.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(6) Ch. Wtr; Dom. cold wtr; Storm; Cold condensate
(7) Ch. Wtr; Brine; Refrig lines

Minimum ‘R’ does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

A minus 10 percent tolerance, on the insulation performance listed shall be permitted for manufacturers' standard insulation systems

SECTION 11

1. FLEXIBLE CONNECTORS

Rubber Expansion Joints – Flexible Rubber Expansion Joints TO I be suitable used on all equipments such as pumps and chillers at both suction and discharge outlets. Each connector should consist of a single unfilled arch along with integral rubber flanges and should be furnished with a set of galvanized split retaining rings. Materials of construction will include Neoprene tube reinforced with multiple plies of Nylon tire cord with a Neoprene Cover. There will be metal reinforcement rings

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
in the connector to add support. The flexible rubber expansion joint shall be rated as follows should be rated for a working pressure of 7 bar and a test pressure of 10 bar. All connectors must have a burst pressure of at least 3:1 over the above rated pressure. Control Rod Assemblies must be used on all unanchored systems; all systems with pump mounted on rubber vibration pads or spring vibration mounts; all systems where pressures or movements may exceed the published limits of the connectors; When control rods are used, they must be set so that axial extension movement of the connector shall not exceed the published limit of the connector; Rubber Expansion Joints shall be Easyflex Model 812, as manufactured by Kanwal Industrial Corporation.

2. FLEXIBLE DUCTS:

The Flexible duct shall be Mold and mildew resistant, UL181 listed and comply with NFPA Standards 90A and 90B, self-extinguishing, moisture resistant core, bi-directional reinforced metallized vapor barrier, acoustically rated, self-extinguishing chlorinated polyethylene (CPE) core permanently bonded to a coated spring steel wire helix that supports an ample blanket of fiberglass insulation, providing a double air seal.

Ducts shall be suitable for use in low and medium pressure heating and cooling systems, Temp. Range: -20F to 250F cont, R-Value: R-4.2, R-6.0, GREENGUARD Certified

The Flexible ducts to be in accordance with the guidelines issued by the Air Diffusion Council (ADC) and Underwriters Laboratories, Inc., (UL) to evaluate listed air ducts and air connectors for thermal resistance properties in accordance with the ADC Flexible Duct Performance & Installation Standard (1991, Revised 1996), using ASTM C-518 (1991) at installed wall thickness on flat insulation only.

SECTION 12

TESTING, ADJUSTING AND BALANCING (T A B)

1.01 SUMMARY

A. Perform all work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:

1. Responsibilities of project contractor.

2. Preparation for balancing of air systems.

B. The scope of the TAB work is responsibility of the HVAC Contractor to satisfactorily execute the TAB work as per ASHRAE SMACNA. The Contractor in his original bid shall allow for the costs required to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.02 SCOPE OF WORK

A. Testing, adjusting, and balancing (TAB) of the air conditioning and ventilation systems and related ancillary equipment will be performed.

B. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc. required for correct balance as advised by the TAB firm, at no additional cost to the Owner.
C. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.

D. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate said systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be subject to the approval of the Construction Inspector.

E. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The contractor shall allow adequate time for the testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

F. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Construction Inspector shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.03 RESPONSIBILITIES OF THE PROJECT CONTRACTOR:

A. The Contractor shall:

1. Have the HVAC systems in complete operational readiness for TAB work to begin.

2. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:

   Air Distribution Systems:

   a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by the Specification.

   b. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.

   c. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices installed.

   d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessive bypass or leakage of air.

   e. All fans (supply, return and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating; record motor amperage and voltage on each phase at start-up and running, and verify they do not exceed nameplate ratings.

3. Water Circulating Systems:

   a. Check and verify pump alignment and rotation.

   b. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and checked for proper operation, remove and clean all strainers. The Contractor shall repeat the operation until circulating water is clean.

   c. Record each pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.
d. Verify that the electrical heater elements are of the proper size and rating.

e. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.

f. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

4. Automatic Controls:

   a. The Contractor shall establish the requirements and present the control scheme and check sequences of operation for correctness.

   b. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, dampers sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.

   c. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB firm and Control Contractor.

5. Tabulated Data: The motor amperages, voltages shall be recorded showing “actual” and "nameplate" voltage and amperage and submitted and actual RPM. This applies to each piece of electrically driven air conditioning equipment in the system including supply and exhaust fans, fans of fractional horsepower, pumps, etc.

D. Notification of System Readiness:

   1. After completion of the work, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building HVAC systems are in operational readiness. A copy of the tabulated report data to be submitted to Owner.

SECTION- 13

ELECTRICAL WORKS

1.0 SCOPE

The scope of this section comprises of supply, erection, testing and commissioning of complete power distribution covering power distribution cum Motor Control Centre (MCC), Power cabling and earthing etc for HVAC system.

2.0 GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

CPRI type tested design shall be adopted for the motor control centers. All equipments shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply system with solidly earthed neutral.

3.0 CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) cum power distribution board shall be fully compartmentalised fabricated out of CRCA sheet steel. Wherever specified the same shall be suitable for outdoor installation, dead front, floor mounting/wall mounting type. The control panel shall be totally enclosed, completely dust and vermin proof and shall have hinged doors with Neoprene gasket.
Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to relevant Codes, approved standards.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A base channel of 75 mm x 75 mm x 5 mm thick shall be provided at the bottom for floor-mounted panels. Minimum clearance of 400 mm shall be provided between the floor of control panel and the lowest unit.

The panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier arrangement. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required. Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and minimum clearance between phase and earth shall be 20 mm and phase-to-phase shall be 25 mm.

4.0 WIRING SYSTEM

All L T power cabling between MCC and motors shall be carried out with 1100 volts grade PVC insulated, overall PVC sheathed aluminium / copper conductor armoured cables, Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring shall be 1.5 sq mm of Stranded copper conductor. Minimum size of conductor for power wiring shall be of 4 sq. mm in case of Aluminium Conductor & 2.5 sqmm in case of Copper conductor.

5.0 CIRCUIT COMPARTMENT

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker-opening handle in the “ON” position. Safety interlocks shall be provided to prevent the breaker from being drawn-out when the breaker is in ‘ON’ position. The door shall not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6.0 INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar ‘ON’ lamps shall be provided on all outgoing feeders.

7.0 BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic copper or Aluminium as per specifications and of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic / DMC / SMC insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid copper strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.00-amps/mm² cross-section area.
8.0 TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per relevant Codes, and approved standards.

9.0 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables as per approved for construction shop drawing.

10.0 AIR CIRCUIT BREAKERS (ACB)

Air Circuit Breakers shall be sheet metal enclosed flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3 pole with modular construction, drawout, manually operated and shall be capable of providing short circuit, overload and earth fault protection through micro processor based control unit sensing the true RMS value to ensure accurate measurement meeting the EMI/EMC requirement as per standard.

The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity shall be as specified on the single line diagram and shall be equal to the short circuit withstand values.

Circuit breakers shall be designed to ‘close’ and ‘trip’ without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel and integral with the breaker.

The ACB shall be provided with a door interlock. The contacts shall be of silver plated copper with a feature of contact wear inspection, indicating the life of the contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts.

11.0 CRADLE

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Service Position: Main Isolating contacts and control contacts of the breaker are engaged.

Test Position: Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position: Both main isolating and control contacts are isolated.

Maintenance: Circuit breaker fully outside the panel ready for maintenance after the cubicle door is opened.
There shall be provision for locking the breaker in any or all of the first three positions.

12.0 PROTECTIONS

a. The Microprocessor based release unit shall be provided on circuit breaker for short circuit, over current and earth fault protection with adjustable settings.

   The release shall incorporate an 8-bit micro-computer to offer accurate and versatile protection with complete flexibility and shall offer complete overcorrect protection to the electrical system in the following four zones:

   9 Overload or long time protection.
   10 Short circuit or short time protection with intentional delay.
   11 Instantaneous protection with no intentional delay.
   12 Ground fault protection.
   13 True RMS sensing.

   The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. Thermal Memory

   When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics:

   A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve. Available pick-up and time delay settings shall have flexibility for over two million different I-t characteristics to suit different applications.

d. Trip Indication

   Electromechanical fault status indicators shall be provided to display the type of fault that caused a trip, without any auxiliary supply or battery, resulting in faster fault diagnosis and reduced system down time.

e. Test Facility

   Test facility to test the operation of the release in different protection zones by simulating CT inputs externally through a testing kit.

f. Self powered

   The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

g. Tripping of the breaker

   The release shall trip the breaker through a flux shift device which shall directly act on the breaker trip rod.
h. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the damage to the system.

j. The setting range of release shall be as follows:

<table>
<thead>
<tr>
<th>TYPE OF PROTECTION</th>
<th>PICK-UP CURRENT</th>
<th>TIME DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LONG TIME</strong></td>
<td>0.5 to 1.0 times I₀ (I₀)</td>
<td>0.2 to 30 sec at 6 I₀</td>
</tr>
<tr>
<td></td>
<td>Steps: 0.50, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, and 1.00.</td>
<td>Steps 0.2, 0.5, 1.5, 2, 3.5, 5, 6, 12, 17, and 30 secs</td>
</tr>
<tr>
<td></td>
<td>Operating Limit: 1.05 to 1.2 times I₀</td>
<td>Tolerance: Corresponding to ±10% of current.</td>
</tr>
<tr>
<td><strong>SHORT TIME</strong></td>
<td>2 to 10 times I₀</td>
<td>20 ms to 600 ms</td>
</tr>
<tr>
<td></td>
<td>Steps: 2, 3, 4, 5, 6, 7, 8, 9 &amp; 10</td>
<td>Steps 20, 60, 100, 160, 200, 260, 300</td>
</tr>
<tr>
<td></td>
<td>Tolerance: ±15%</td>
<td>400, 500 and 600 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tolerance: ±10% or 20 ms Whichever is higher</td>
</tr>
<tr>
<td><strong>INSTANTANEOUS</strong></td>
<td>2 to 16 times Iₘ</td>
<td>100 ms to 400 ms</td>
</tr>
<tr>
<td></td>
<td>Steps: 2, 3, 4, 6, 8, 10, 12, 14, 16 one position as infinity.</td>
<td>Steps 100, 200, 300, 400 ms &amp; Infinity</td>
</tr>
<tr>
<td></td>
<td>Tolerance: ±15%</td>
<td>Tolerance: ±10% or 20 ms, whichever is higher</td>
</tr>
<tr>
<td><strong>GROUND FAULT</strong></td>
<td>0.2 to 0.6 time Iₘ</td>
<td>100 ms to 400 ms</td>
</tr>
<tr>
<td></td>
<td>Steps: 0.2, 0.3, 0.4, 0.5, 0.6</td>
<td>Steps 100, 200, 300, 400 ms &amp; Infinity</td>
</tr>
<tr>
<td></td>
<td>Tolerance: ±15%</td>
<td>Tolerance: ±10% or 20 ms, whichever is higher</td>
</tr>
</tbody>
</table>

Settings shall be by rotary switches having red knob for pick-up currents and blue knobs for time delays.

Factory Settings:

The release shall be set at the following values at the time of shipping:

LTP=0.5, LTD=2s, STP=9, STD=100 ms, IP=Infi, GFP=0.3, GFD=100 ms, Memory=OFF

II. Under voltage relay for voltage is less than 90% of the rated voltage (415 V) shall be provided in the incomer breaker only.

III. Over voltage relay for voltage more than 110% of the rated voltage (415 V) shall be provided in the incomer breaker only.
k. Minimum 6 NO and 6 NC auxiliary contacts shall be provided on each breaker. The contacts shall be rated 5 amps.

l. Rated insulation voltage shall be 1000 volts AC.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open.

All current carrying parts shall be silver-plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The heat generated in the contacts due to tripping under fault conditions shall be very nominal. All air circuit breakers shall be labelled.

13.0 SAFETY FEATURES

I. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

II. It shall not be possible to interchange two circuit breakers of two different thermal ratings.

III. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

IV. Arc Chute covers wherever necessary shall be provided.

V. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and current transformers.

VI. It shall be possible to bolt the drawout frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

14.0 MOULDED CASE CIRCUIT BREAKER (MCCB)

All MCCB’s shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB’s shall be capable of defined Variable overload adjustment. All MCCB’s rated 200 Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimize the let thru’ energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB’s shall be asked for in the schedule of quantities. The breaking capacities specified will be ICU=ICS i.e type-2. Co-ordination as per relevant BIS and IEC Codes.

The MCCB’s shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of ‘ON’, ‘OFF’ or ‘Tripped’ thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 poles MCCB the neutral shall be defined and capable of offering protection.

15.0 MINIATURE CIRCUIT BREAKER (MCB)
Miniature Circuit Breaker shall comply with relevant BIS Codes and shall be quick make and break type for 230/415 VAC 50 Hz applications with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class 3). MCBs shall have type 'C' characteristic. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

16.0 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per relevant BIS code.

17.0 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

18.0 METERS

i. All voltmeters and indicating lamps shall be protected by MCB’s.

ii. Meters and indicating instruments shall be flush mounts type.

iii. CT ratio and burdens shall be as specified on the Single line diagram.

19.0 CURRENT TRANSFORMERS

Current transformers shall be provided for feeders rated 15 HP and above. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block, which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

20.0 SELECTOR SWITCH

Selector switches where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

21.0 STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant IS Codes. All Star Delta and ATS Starters shall be fully automatic. Each starter shall be provided with Motor Protective Circuit Breaker (MPCB) to suite the connected motor.

22.0 CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.
Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils shall be of Class “E”.

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply.

(d) **THERMAL OVERLOAD RELAY**

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three-phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 30 HP capacity. C.T. Operated relays shall be provided for motors above 30 HP capacity. Heater circuit contactors may not be provided with overload relays.

**24.0 TIME DELAY RELAYS**

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

**25.0 INDICATING LAMP AND METERING**

All meters and indicating lamps shall be in accordance with relevant BIS standards. The meters shall be flush mounted type. The indicating lamp shall be of LED type. Each MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. All voltage circuits shall be protected by MCBs.

**26.0 TOGGLE SWITCH**

Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS Codes and shall be of 5 amps rating.

**27.0 PUSH BUTTON STATIONS**

Push button stations shall be provided for manual starting and stopping of motors / equipment. Green and Red colour push buttons shall be provided for ‘Starting’ and ‘Stopping’ operations. ‘Start’ or ‘Stop’ indicating flaps shall be provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door. Lock lever shall be provided for ‘Stop’ push buttons. The push button contacts shall be suitable for 6 amps current capacity.

**28.0 CONDUITS**

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16-gauge upto 32 mm dia and 14 gauges above 32 mm dia conduit. Screwed G.I. conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.
Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or MS Conduits are given below:

<table>
<thead>
<tr>
<th>Size of wires Nominal Cross section Area (Sq. mm.)</th>
<th>Maximum number of wires within conduit size(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>5</td>
</tr>
<tr>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>--</td>
</tr>
<tr>
<td>16</td>
<td>--</td>
</tr>
<tr>
<td>25</td>
<td>--</td>
</tr>
<tr>
<td>35</td>
<td>--</td>
</tr>
</tbody>
</table>

29.0 CABLES

M.V. Cables shall be PVC insulated aluminium conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for lying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

30.0 CABLE LAYING

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimize the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

31.0 WIRE AND WIRE SIZES

1100 volts grade PVC insulated copper conductor wires in conduit shall be used. For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring, cabling shall be of the following sizes:
i. Upto 5 HP motors/5 KW heaters - 3 x 4 sq. mm copper conductor.

ii. From 6 HP to 10 HP motors/6 KW to 7.5 KW heaters
   - 2 Nos. 3 x 6 sq. mm copper conductor.

iii. From 12.5 HP to 15 HP motors with star delta starters
   - 2 Nos. 3 x 6 sq. mm copper conductor.

iv. From 20 HP to 25 HP motors with star delta starters
   - 2 Nos. 3 x 10 sq. mm copper conductors

v. From 30 HP to 35 HP motors with star delta starters
   - 2 Nos. 3 x 16 sq. mm copper conductor armoured cable.

vi. From 40 HP to 50 HP motors with star delta starters
   - 2 Nos. 3 x 25 sq. mm aluminium conductor armoured cable.

vii. From 60 HP to 75 HP motors with star delta starters
     - 2 Nos. 3 x 35 sq. mm armoured cable.

viii. 100 HP motors
      - 1 No. 3 x 150 sq. mm
      - 1 No. 3 x 240 sq. mm armoured cable.

ix. 150 HP motor
    - With soft starters
    - 1 No. 3 x 240 sq. mm armoured cable.

x. 250 HP motor
    - With soft starters
    - 2 Nos. 3 x 240 sq. mm armoured cable.

xi. 400 HP motor
    - With soft starters
    - 3 Nos. 3 x 240 sq. mm armoured cable.

xii. 600 HP motor
     - 3 Nos. 3 x 400 sq. mm armoured cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer’s recommendation.

<table>
<thead>
<tr>
<th>TYPE OF STARTER</th>
<th>CONTACTOR CURRENT</th>
<th>OVERLOAD RELAY RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 HP Motors</td>
<td>D O L</td>
<td>16 amps</td>
</tr>
<tr>
<td>7.5 HP motors</td>
<td>D O L</td>
<td>16 amps</td>
</tr>
<tr>
<td>10 HP Motors</td>
<td>D O L</td>
<td>25 amps</td>
</tr>
<tr>
<td>12.5 HP Motors</td>
<td>Star Delta</td>
<td>16 amps</td>
</tr>
<tr>
<td>15 HP Motors</td>
<td>Star Delta</td>
<td>25 amps</td>
</tr>
<tr>
<td>20 HP Motors</td>
<td>Star Delta</td>
<td>32 amps</td>
</tr>
<tr>
<td>25 HP Motors</td>
<td>Star Delta</td>
<td>32 amps</td>
</tr>
<tr>
<td>30 HP Motors</td>
<td>Star Delta</td>
<td>40 amps</td>
</tr>
<tr>
<td>35 HP Motors</td>
<td>Star Delta</td>
<td>40 amps</td>
</tr>
<tr>
<td>40 HP Motors</td>
<td>Star Delta</td>
<td>40 amps</td>
</tr>
<tr>
<td>50 HP Motors</td>
<td>Star Delta</td>
<td>70 amps</td>
</tr>
<tr>
<td>HP Motors</td>
<td>Star Delta</td>
<td>110 amps</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>75 HP Motors</td>
<td>Star Delta</td>
<td>110 amps</td>
</tr>
<tr>
<td>100 HP Motors</td>
<td>Soft Starter</td>
<td>200 amps</td>
</tr>
<tr>
<td>125 HP Motors</td>
<td>Soft Starter</td>
<td>200 amps</td>
</tr>
<tr>
<td>150 HP Motors</td>
<td>Soft Starter</td>
<td>200 amps</td>
</tr>
<tr>
<td>300 HP Motors</td>
<td>Soft Starter</td>
<td>400 amps</td>
</tr>
<tr>
<td>400 HP Motors</td>
<td>Soft Starter</td>
<td>600 amps</td>
</tr>
<tr>
<td>600 HP Motors</td>
<td>Soft Starter</td>
<td>900 amps</td>
</tr>
</tbody>
</table>

Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

### 32.0 EARTHING

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips /wires. The main panel shall be connected to main earthing system of the power supply. All single-phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / tapes as follows:

i. Motor upto and including 10 HP rating. 2 Nos. mm dia copper wires.

ii. Motor 12.5 HP to 40 HP capacity. 2 Nos. 4 mm dia copper wires.

iii. Motor 50 to 75 HP capacity 2 Nos. 6 mm dia copper strip

iv. Motor above 75 HP. 2 Nos. 25 mm x 3 mm copper strips.

All switches shall be earthed with two numbers distinct and independent copper wires' tapes as follows:

i. 3 phase switches and control panels upto 60 amps rating. 2 nos. 10 sq mm size copper conductors.

ii. 3 phase switches, and control panels 63 amps to 100 amps rating. 2 Nos. 16 sq mm size copper conductors.

iii. 3 phase switches and control panels 125 amps to 200 amps rating. 2 Nos. 25 x 6 mm GI strips

iv. 3 phase switches, control panels, bus ducts, above 200 amps rating. 2 Nos. 40 x 6 mm GI strips

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be welded / crimping type lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance.

### 33.0 DRAWINGS
Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of Architect/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete “As-installed” drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

34.0 TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorized person. The entire electrical installation shall be gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Owner’s site representative. Testing of the panels shall be as per relevant BIS Codes:

35.0 PAINTING

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.

36.0 MEASUREMENT OF ELECTRICAL CONTROL PANELS

Panels shall be counted as number of units. Quoted rates shall include as lumpsum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for interlocking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate of panel shall also include all accessories, switchgear, contactors, indicating meters and lights as per the Specifications and Schedule of Quantities. The end terminations to be included in the cable rate.

37.0 RUBBER MAT

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

38.0 CABLE TRAYS

The cable tray shall be fabricated out of 2 mm thick pregalvanized sheet steel using proper jigs and fixtures.

All accessories such as bends, tees etc., shall also be manufactured at the tray manufacturer’s works. Maa Industries, (Profab) Mumbai make cable trays shall be preferred. These shall not be fabricated at site.

Perforated cable trays shall be of similar material with 1.6 mm thick G.I cover on top retained. In position by screws

Cable tray sections shall be joined by fishplates.

The accessories like bends, reducers, etc., of similar material with galvanized hardware shall be supplied.
SECTION 14

PROGRAMMABLE LOGICAL CONTROL SYSTEMS

14 GENERAL

SECTION INCLUDES
A. Control equipment.
B. Software.

REFERENCES
B. ASME MC85.1 - Terminology for Automatic Control.

DEFINITIONS
A. Ensure terminology used in submittals conforms to [ASHRAE 85.] [ASME MC85.1.] [NEMA EMC1.]

SYSTEM DESCRIPTION
A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units, with communications to Building Management System.
B. Central and remote hardware, software, and interconnecting wire and conduit.
C. Air handling units, Pumps, valves, instruments, and Terminal unit controls for variable air volume terminals, fan coils, pneumatic or electric unless indicated otherwise.
D. Damper Motors and Valve Operators: [Pneumatic.] [Electronic.]

SUBMITTALS
A. Submit under provisions of Section 01
B. Shop Drawings:
   1. Trunk cable schematic showing programmable control unit locations, and trunk data conductors.
   2. List of connected data points, including connected control unit and input device.
   3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   5. Descriptive data and sequence of operation of operating, user, and application software.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
12 Product Data: Provide data for each system component and software module.

13 Manufacturer's Installation Instructions: Include for all manufactured components.

**PROJECT RECORD DOCUMENTS**

A. Submit under provisions of Section 01
B. Accurately record actual location of control components, including panels, thermostats, and sensors.
C. Revise shop drawings to reflect actual installation and operating sequences.
D. Include data specified in "Submittals" in final "Record Documents" form.

**OPERATION AND MAINTENANCE DATA**

A. Submit under provisions of Section 1
B. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.
C. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
D. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

**QUALIFICATIONS**

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum FIVE years proven experience.
B. Installer: Company specializing in applying the work of this Section with minimum five years experience

12 Design system software under direct supervision of a Professional Engineer experienced in design of this work and licensed [at the place where the Project is located.

**COORDINATION**

A. Coordinate work under provisions of Section 1
B. Ensure installation of components is complementary to installation of similar components in other systems.
C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

13 Ensure system is completed and commissioned.

**WARRANTY**

A. Provide five-year warranty from the date of commissioning.
B. Warranty: Include coverage for field programmable micro-processor based units.

**PROTECTION OF SOFTWARE RIGHTS**

A. Prior to delivery of software, the Owner and the party providing the software will enter into software license agreement with provisions for the following:
Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

3.10.2 PRODUCTS

MANUFACTURERS

(a) JOHNSONS
(b) SAUTER
(c) SEIMENS
(d) HONEYWELL
(e) ABB
(f) MITSUBISHI

LOCAL OPERATOR ACCESS AND DISPLAY PANEL

A. Provide local display and adjustment panel. Panels shall be [portable] [or] [integral to] programmable control unit. Panel contains a six character digital display, and a numerical keyboard. Display and adjust:

1. Input/output point information.

2. Controller set points.

3. Controller tuning constants.

4. Program execution times.

5. High and low limit values.


7. Time, date, year.


C. Provide status lights to annunciate controller test, trouble, alarm, auto control, override, and auxiliary button operation.

OPERATOR STATION

A. Operator Input/Output Devices:


2. Interface with standard EIA (Electronic Industries Association) hardware through EIA RS-232-C communications port over telephone lines through a suitable modem interface, or via dial-up network with auto-answer modems.

3. System loading shall be through CD.[floppy disk.]

4. Communication between the central processing unit and programmable control units, and between programmable control units shall be normally 9600 baud, by block mode transmission with cyclical redundant error checking, supervised for system integrity and for monitoring field point status.
5. Station includes multiple input/output devices which can be used simultaneously, having on-line definable characteristics.

6. Provide Building Environmental Control Center consisting of video display terminal, hard copy printer, and audible alarm horn.

B. Printer:
   1. Wide carriage with output of ten OR twelve OR fifteen characters per inch and 132 characters per line of paper, capable of using fan-fold paper. Laser printer preferred.

C. Terminal:
   1. 300 mm diagonal display with adjustable tilt.
   2. 24 line, 80 character color screen.
   3. Automatic screen blanking after timed inactivity.
   4. Low profile, detachable, keyboard having standard typewriter layout plus a 10 key numeric keypad, dedicated function keys.

CONTROL UNITS

A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.

B. Battery Backup: For minimum of 100 hours for complete system including RAM without interruption, with automatic battery charger.

C. Provide the following functions:
   1. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.
   2. Logic: OR, AND, compare negate.
   3. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, and filter.
   5. Display Panel: Display adjust, override, time, day, date, year, alarm scan, override scan.
   6. Control Routines: Proportional, integral, lead lag, hysteresis correction and incremental control.
   7. Energy Management: Duty cycling, load shed, optimal run time, holiday and daylight savings time correction.

D. Provide self-test procedure for checking digital display and computer. Display advisories for maintenance, performance, or software problems. Identify variables as reliable or unreliable. Variables identified as unreliable will flash when displayed and calculation will use default.

E. Indicate alarms and deviations. Alarm scan shows alarms and identification. Continue alarm indication until acknowledged and alarm condition is corrected.

F. Provide two communication interface ports permitting communication between processor, process interface equipment, other processors, and central processing unit as specified.

DATA INTERFACE UNITS

A. Provide equipment required to connect all sensors, transducers and interface relays required to monitor and control equipment in sequence of operation.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
B. Provide each data interface equipment module with minimum of binary and analog inputs, and binary and analog outputs.

INPUT/OUTPUT SENSORS

A. Temperature:

1. Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 21 degrees C, interchangeability less than plus or minus 0.2 percent C, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.

2. Measuring current maximum 5 MA with maximum self-heat of 0.017 degrees C/MW in fluids and 0.008 degrees C/MW in fluids and 0.008 degrees C/MW in air.

3. Provide 3 lead wires and shield for input bridge circuit.

4. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 2.5 m or 5 m as required.

5. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches (60 mm).

6. Supply room sensors with locking cover.

7. Provide outside air sensors with watertight inlet fitting, shielded from direct rays of sun.

B. Humidity Sensors:

1. Elements: Accurate within 5 percent full range with linear output.

2. Room Sensors: With locking cover, span of [10 to 60 percent relative humidity.] [30 to 80 percent relative humidity.]

3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.

C. Static Pressure Sensors:

1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.

2. Temperature compensated with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F (5 to 40 degrees C).

3. Accuracy: One percent of full scale with repeatability 0.3 percent.

4. Output: 0 - 5 vdc with power at 12 to 28 vdc.

D. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg (0 to 1250 Pa).

2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi (50 to 400 kPa).


E. Digital to Pneumatic Transducers: Convert [plus or minus 12 vdc pulse widths] [continuous proportional current or voltage] to 0 to 20 psi (0 to 138 kPa).
amper Position Indication: Potentiometer mounted in handbox enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

G. Carbon Monoxide Detectors:
1. Single or multichannel dual level detectors, using solid state sensors with three year minimum life. Sensor replacement shall take maximum 15 minutes. Suitable over temperature range of 23 to 130 degrees F (-5 to 55 degrees C).
2. Provide individual indicators and contactors for each level, initially calibrated for 50 ppm and 100 ppm.
3. Maximum response time to 100 ppm CO calibration gas shall be two minutes.

OPERATING SYSTEM SOFTWARE

A. System Format:
1. Divide points of control or monitoring by system.
2. Identify points with unique, structured point identifier reflecting “specific area” or “specific system”, and “specified point”.

B. Input Process:
1. Select, from menu, one of four general types of commands based upon password clearance, command points, information points, builds parameters, and modify parameters. Commands not available by password clearance shall be deleted from video display.
2. Enter memory changes through keyboard.
3. Select entry modes, Aid or Direct, based on operator’s degree of capability and familiarity with system.
4. Aid Mode shall prompt operator through each step indicating available options.
5. Direct Mode shall allow experienced operator to input command string directly.
6. Enter commands as alpha/numeric character strings. Where commands require data for limits, set point, and time, enter value in same engineering units as controlled variable.
7. Operator input shall not inhibit alarm reporting. Echo input on associated output device, to either execute or abort.

C. Operator Access Control: Restrict any operator commands through use of software password.

D. Information Access: Obtain point status information from any designated output device with access command. Point status consists of point identification, numerical value (analog points) and associated engineering units, and individual function label indicating that point is on or off or in Alarm Normal condition. Output includes date and time of execution.

E. Point Display: Video display includes status of single point or group of points with high and low limits (if applicable). Refresh display at least every 20 seconds.

F. Alarm summary includes status of points in Alarm condition.

G. Off-normal summary includes status of points in Off-Normal condition.

H. Alarm Reporting:
1. Alarm outputs contain descriptor, point identification, point data, engineering units, and date and time.

2. Inhibit reporting of associated analog and binary alarms upon HVAC system shutdown. Upon restart, inhibit alarm reporting for operator pre-determined time.

5. Operator specifies if alarm required acknowledgement.

I. Advisories:
   1. Lockout summary which contains status of points in locked out condition.
   2. Continuously interrogate system hardware and programmable control units for failure or tampering and report if operational or not operational.
   3. Power failure detection, time and date.
   4. System communication failure with operator device, field interface unit, point, programmable control unit.

J. Data Base Save/Restore:
   1. Provide program which allows saving or restoring of operating data.
   2. [Cassette tape] or [Floppy disk] unit shall save or restore system operating data.
   3. Data includes:
      a. Analog limits and differentials
      b. Start-stop times
      c. Access/secure times
      d. Lockout/unlock times
      e. Set point values and adjustment times
      f. Limits and differential values
      g. Totalization points, limits, and current values
      h. Alarm messages and their assignments
      i. Load control program operational parameters
      j. HVAC control program operational parameters

K. Power Failure Motor Restart: Provide program to restore systems to normal operating conditions following power outage, and to enforce emergency operating conditions during power outage. Automatically restart loads to correct operating condition if normal or emergency power is available.

**BASIC OPERATING FEATURES**

A. Binary Capabilities:

   1. Monitor binary sensors, continuously storing present contact condition in memory.
   2. Indicate if point is off-normal, in alarm, or off-line.
program output points for Open/Closed, Test/Reset, and Start/Stop.

4. Feedback Start/Stop points. Employ point unique, feedback delay timer to temporarily suppress alarm reporting after input to allow time for response.

5. Output advisory message if response is not as commanded.

6. Hold points in present operating condition if controls power failure occurs.

B Analog Capabilities:

1. Measure, transducer, transmit and display analog values.

2. Express analog point values in proper engineering units, displaying with up to [seven] [six] significant digits.

3. Have sensor to readout accuracy of plus or minus [one degree F (0.56 degrees C.)] [0.5 degrees F (0.28 degrees C.).]

4. Use [English] [S.I. Metric] system of measurement.

5. Provide for operator-designated ranges either linear, series of linear approximations, split ranges, or square root extractions of exponential functions.

6. Compare analog read to high and low limits and annunciate Alarm or Off-Normal condition.

7. Output alarm, including point identification current value and associated engineering units, high or low value, and time and date.

8. Automatically disable alarm reporting upon associated system shutdown. Allow sufficient time to return to normal operating conditions before allowing alarm reporting.


C Analog Point Adjust:

1. Remotely adjust controller set points or dampers. Automatically adjust points based upon preselected time or value.

2. Employ feedback so that if point fails to respond, responds with wrong value, or drifts from set point value by plus or minus 2 percent, output alarm message. Employ feedback delay timer to temporarily suppress alarm reporting after input to allow time for response.

3. Hold points in present operating condition if controls power failure occurs.

D Automatic Alarm Lockout: Automatically inhibit alarm reporting of analog and binary points upon associated system shutdown. Inhibit reporting for operator predetermined time, upon restart of HVAC systems.

LOAD CONTROL PROGRAMS

A General:

1. Provide means to reduce electrical energy usage, using control algorithms designed for electrical energy control.

2. Apply algorithms to other energy sources, such as steam or natural gas.


B Demand Limiting:
1. Monitor total power consumption per power meter and shed associated loads automatically to reduce power consumption to an operator-presettable maximum demand level.

2. Use floating window type demand determination to monitor demand and compare to target value.

3. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.

4. Output advisory if loads are not available to satisfy required shed amount, advice shed requirements [ ] [and requiring operator acknowledgement.]

5. Operator commands:
   a. Add/delete demand meter point.
   b. Define load point.
   c. Define load priority target.
   d. Define control target.
   e. Begin new billing period.
   f. Lock/unlock program.
   g. Activate/inactivate/restore load.
   h. Request load control system control summary.
   i. Request load control system load summary.

6. Load control system summary:
   a. Demand interval
   b. Current kW power and measured demand.
   c. Projected load limit.
   d. Total energy available from HVAC system
   e. Maximum, average, and current expendable load.
   f. Maximum, average and current deferrable load.
   g. Demand limit status, target value, and recent control action.
   h. Duty cycle status, target value, and recent control action.
   i. Convergence time.
   j. Restore band width.

7. Load summary:
   a. Load priority.
   b. Expendable/deferrable load type.
   c. Point type, ID, status.
C Duty Cycling:

1. Periodically turn selected loads off to evenly reduce power consumption to target value, selecting loads with independently adjustable on and off time of between one and 255 minutes.

2. Operator commands:
   a. Define load point.
   b. Define control target.
   c. Activate/inactivate/restore load.

HVAC CONTROL PROGRAMS

A General:

1. Support [English] [S.I. Metric] units of measurement.

2. Identify each HVAC Control system.

B Optimal Run Time:

1. Start-up and shutdown times of HVAC equipment for both heating and cooling.

2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.

3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.

4. Use outside air temperature to determine early shut down with ventilation override.

5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.

6. Operator commands:
   a. Define time schedule.
   b. Add/delete fan status point.
   c. Add/delete outside air temperature point.
   d. Add/delete mass temperature point.
   e. Define heating/cooling parameters.
   f. Define mass sensor heating/cooling parameters.
   g. Lock/unlock program.
request optimal run time control summary.
i. Request optimal run time mass temperature summary.
j. Request HVAC point summary.
k. Request HVAC saving profile summary.

7 Control summary:
   a. HVAC Control system begin/end status.
   b. Optimal run time lock/unlock control status.
   b. Heating/cooling mode status.
   c. Optimal run time schedule.
   d. Start/stop times.
   e. Selected mass temperature point ID.
   f. Optimal run time system normal start times.
   g. Occupancy and vacancy times.
   h. Optimal run time system heating/cooling mode parameters.

8 Mass temperature summary:
   a. Mass temperature point type and ID.
   b. Desired and current mass temperature values.
   c. Calculated warm-up/cool-down time for each mass temperature.
   d. Heating/cooling season limits.
   e. Break point temperature for cooling mode analysis.
   f. Linear compensation factor for heating mode analysis.

9 HVAC point summary:
   a. Control system identifier and status.
   b. Fan status, point ID and status.
   c. Outside air temperature point ID and status.
   d. Mass temperature point ID and status.
   e. Calculated optimal start and stop times.
   a) Period start.

C Supply Air Reset:

1  Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot
deck and cold deck temperatures on dual duct and multizone systems, single zone unit
   discharge temperatures.
2 Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.

3 Operator commands:
   a. Add/delete fan status point.
   b. Lock/unlock program.
   c. Request HVAC point summary.
   d. Add/Delete discharge controller point.
   e. Define discharge controller parameters.
   f. Add/delete air flow rate.
   g. Define space load and load parameters.
   h. Request space load summary.

4 Control summary:
   a. HVAC control system status (begin/end).
   b. Supply air reset system status.
   c. Optimal run time system status.
   d. Heating and cooling loop.
   e. High/low limits.
   f. Dead band.
   g. Response timer.
   h. Reset times.

5 Space load summary:
   a. HVAC system status.
   b. Optimal run time status.
   c. Heating/cooling loop status.
   d. Space load point ID.
   e. Current space load point value.
   f. Control heat/cool limited.
   g. Gain factor.
   h. Calculated reset values.
   i. Fan status point ID and status.
i. Control discharge temperature point ID and status.

j. Space load point ID and status.

k. Air flow rate point ID and status.

D. Enthalpy Switchover:

1. Calculate outside and return air enthalpies using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.

2. Operator commands:
   a. Add/delete fan status point.
   b. Add/delete outside air temperature point.
   c. Add/delete discharge controller point.
   d. Define discharge controller parameters.
   e. Add/delete return air temperature point.
   f. Add/delete outside air dew point/humidity point.
   g. Add/delete return air dew point/humidity point.
   h. Add/delete damper switch.
   i. Add/delete minimum outside air.
   j. Add/delete atmospheric pressure.
   k. Add/delete heating override switch.
   l. Add/delete evaporative cooling switch.
   m. Add/delete airflow rate.
   n. Define enthalpy deadband.
   o. Lock/unlock program.
   p. Request control summary.
   q. Request HVAC point summary.

3. Control summary:
   a. HVAC control system begin/end status.
   b. Enthalpy switchover optimal system status.
   c. Optimal return time system status.
   d. Current outside air enthalpy.
   e. Calculated mixed air enthalpy.
   f. Calculated cooling cool enthalpy using outside air.
calculated cooling cool enthalpy using mixed air.

h. Calculated enthalpy difference.
i. Enthalpy switch over deadband.
j. Status of damper mode switch.

PROGRAMMING APPLICATION FEATURES

A. Trend Point:
   1. Sample up to points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month.
   2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique [pattern] [color], vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:
   1. Allow definition of minimum of messages, each having minimum length of characters for each individual message.
   2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, and hardware elements advisories.
   3. Output assigned alarm with "message requiring acknowledgement".
   4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:
   1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
   2. Provide program times for each day of week, per point, with [one] minute resolution.
   3. Automatically generate alarm output for points not responding to command.
   5. Operator commands:
      a. System logs and summaries.
      b. Start of stop point.
      c. Lock or unlock control or alarm input.
      d. Add, delete, or modify analog limits and differentials.
      e. Adjust point operating position.
      f. Change point operational mode.
      g. Open or close point.
h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.

i. Begin or end point totalization. - Modify totalization values and limits.

j. Access or secure point.

k. Begin or end HVAC or load control system.

l. Modify load parameter.

m. Modify demand limiting and duty cycle targets.

6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:

1. Permit events to occur, based on changing condition of one or more associated master points.

2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.

3. Operator commands:
   a. Define single master/multiple master interlock process.
   b. Define logic interlock process.
   c. Lock/unlock program.
   d. Enable/disable interlock process.
   e. Execute terminate interlock process.
   f. Request interlock type summary.

3.10.3 EXECUTION

INSTALLATION

11 Install in accordance with manufacturer's instructions and standard electrical works recommended practice.

C. Provide with 1 20v AC, 15 amp dedicated emergency power circuit to each programmable control unit.

MANUFACTURER'S FIELD SERVICES

A. Preparing and start up of systems.

DEMONSTRATION

A. Demonstrate complete and operating system to Owner.

INPUT/OUTPUT SCHEDULE

<table>
<thead>
<tr>
<th>POINT DESCRIPTION</th>
<th>POINT</th>
<th>POINT</th>
<th>POINT</th>
<th>POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Input</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Demand Meter (kw)
Auxiliary Contact
Switches
Switch Closing
Flow Switch
Optical
Current
Pressure
Digital Output
Control Relay
Solenoid
Contactor
Analog Input
Temperature Sensors
Outdoor Air Space
Pipe Supply
Pipe Return
Duct Supply
Duct Return
Duct Mixed Air
Stack Temperature
Humidity Sensors
Outdoor Space
Duct Pressure/Vacuum
Filter
Flow
Current
Liquid Level
Photocell
Alarm

**INPUT/OUTPUT SCHEDULE**

<table>
<thead>
<tr>
<th>POINT DESCRIPTION</th>
<th>POINT</th>
<th>POINT</th>
<th>POINT</th>
<th>POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POINT_TYPE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Humidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumatic Position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic Position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set Point Adjust</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start/Stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off/Low/High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Features</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PID Control (DDC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Limit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Low Limit
Run Time Totalization
Consumption Totalization
Program Start/Stop
Load Shed
Duty Cycle
Enthalpy Switchover
Optimal Run Time
Supply Air Reset
O.A. Interlock
O.A Temp. Reset
Free Cooling Mode
Warm-up Mode
Boiler Interlock

Chiller Sequencing
Energy Calculation

ALARM SCHEDULE

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>High Limit</td>
</tr>
<tr>
<td>A2</td>
<td>Low Limit</td>
</tr>
<tr>
<td>A3</td>
<td>Run Time</td>
</tr>
<tr>
<td>A4</td>
<td>Maintenance</td>
</tr>
<tr>
<td>A5</td>
<td>Status</td>
</tr>
<tr>
<td>A6</td>
<td>Override</td>
</tr>
<tr>
<td>A7</td>
<td>Freeze</td>
</tr>
<tr>
<td>A8</td>
<td>Low Pressure</td>
</tr>
</tbody>
</table>

SECTION: 15 FIELD DEVICES

DIFFERENTIAL PRESSURE SWITCH (AIR) WITH DISPLAY

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medium</td>
<td>Air and non-corrosive gases</td>
</tr>
<tr>
<td>2</td>
<td>Setting range</td>
<td>20 to 300 Pa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 to 500 Pa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 to 1000 Pa</td>
</tr>
<tr>
<td>3</td>
<td>Pressure</td>
<td>5000 Pa overpressure</td>
</tr>
<tr>
<td>4</td>
<td>Hysteresis</td>
<td>10 Pa (/300)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 Pa (/500)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 Pa (/1 000)</td>
</tr>
<tr>
<td>5</td>
<td>Contact</td>
<td>Single pole changeover rated 250 Vac @ 5 A (resistive) or 30 Vdc @ 2A</td>
</tr>
<tr>
<td>6</td>
<td>Life:</td>
<td>10 6 switching cycles</td>
</tr>
<tr>
<td>7</td>
<td>Pressure</td>
<td>20 Pa</td>
</tr>
<tr>
<td>8</td>
<td>Repeatability</td>
<td>± 2.5 Pa (/300)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 5 Pa (/500 or /1000)</td>
</tr>
<tr>
<td>9</td>
<td>Materials</td>
<td>Fibre-glass reinforced plastic</td>
</tr>
<tr>
<td>9.1</td>
<td>Case</td>
<td>Plastic</td>
</tr>
<tr>
<td>9.2</td>
<td>Cover</td>
<td>Plastic</td>
</tr>
<tr>
<td>10</td>
<td>Diaphragm</td>
<td>Silicone LSR</td>
</tr>
<tr>
<td>Sl No</td>
<td>Description</td>
<td>Remarks</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Setting range</td>
<td>DPSL/L 40 to 200 mbar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DPSL/H 150 to 1000 mbar</td>
</tr>
<tr>
<td>2</td>
<td>Maximum Operating Pressure</td>
<td>2.1 DPSL/L 10000 mbar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2 DPSL/H 20000 mbar</td>
</tr>
<tr>
<td>3</td>
<td>Cable gland</td>
<td>PG9 thread (female in body)</td>
</tr>
<tr>
<td>4</td>
<td>Contact</td>
<td>± 5% of switching point (± 0.4 mbar minimum)</td>
</tr>
<tr>
<td>5</td>
<td>Life:</td>
<td>&gt;10° switching cycles.</td>
</tr>
<tr>
<td>6</td>
<td>Smallest switching</td>
<td>3 mbar</td>
</tr>
<tr>
<td>7</td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Repeatability</td>
<td>± 5% of switching point (± 0.4 mbar minimum)</td>
</tr>
<tr>
<td>9</td>
<td>Materials</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Weight</td>
<td>1000g</td>
</tr>
<tr>
<td>11</td>
<td>Electrical</td>
<td>Screw terminals</td>
</tr>
<tr>
<td>12</td>
<td>Pressure Connections</td>
<td>G1/8&quot; (DIN 259), 1/8&quot; BSP female thread;</td>
</tr>
<tr>
<td>13</td>
<td>Protection</td>
<td>IP54</td>
</tr>
<tr>
<td>14</td>
<td>Dimensions</td>
<td>118 x 65 x 65 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120 x 69 x 65 mm (inc bracket)</td>
</tr>
<tr>
<td>15</td>
<td>Temperature (ambient and</td>
<td>10 to 80 °C</td>
</tr>
<tr>
<td></td>
<td>medium)</td>
<td></td>
</tr>
</tbody>
</table>

**Differential Pressure Switch (Air) with Display**

**Thermistor Room Temperature Sensor with Digital Display**

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrical</td>
<td></td>
</tr>
</tbody>
</table>
### Technical Specification

**Duct type Humidity & Temperature Sensor with display**

<table>
<thead>
<tr>
<th>SL No</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Electrical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Humidity measurement range</td>
<td>0 to 95 %RH non-condensing</td>
</tr>
<tr>
<td>1.2</td>
<td>Temperature measurement range</td>
<td>-10 to +70 °C</td>
</tr>
<tr>
<td>1.3</td>
<td>Humidity element H/DT, H/DT/2CC</td>
<td>Resistance change through bulk polymer</td>
</tr>
<tr>
<td>1.4</td>
<td>H/DT/5%</td>
<td>Humidity accuracy of sensor (at 25 °C) including hysteresis, linearity, and repeatability.</td>
</tr>
<tr>
<td>1.5</td>
<td>H/DT</td>
<td>±3 %RH (20 to 90 %RH)</td>
</tr>
<tr>
<td>1.6</td>
<td>H/DT/2CC</td>
<td>±2 %RH (20 to 90 %RH)</td>
</tr>
<tr>
<td>1.7</td>
<td>H/DT/5%</td>
<td>±5 %RH (30 to 70 %RH)</td>
</tr>
<tr>
<td>1.8</td>
<td>Temperature effect on RH</td>
<td>Less than 0.11% per °C</td>
</tr>
<tr>
<td>1.9</td>
<td>Sensitivity</td>
<td>0.1 %RH</td>
</tr>
<tr>
<td>1.10</td>
<td>Hysteresis</td>
<td>Less than 1 %</td>
</tr>
<tr>
<td>1.11</td>
<td>Repeatability</td>
<td>0.5 %RH</td>
</tr>
<tr>
<td><strong>Temperature element</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12</td>
<td>H/DT, H/DT/5%</td>
<td>Thermistor 10 kΩ at 25 °C</td>
</tr>
<tr>
<td>1.13</td>
<td>H/DT/2CC</td>
<td>Platinum 100 O</td>
</tr>
<tr>
<td>1.14</td>
<td>H/DT, H/DT/5%</td>
<td>±0.5 °C</td>
</tr>
<tr>
<td>1.15</td>
<td>H/DT/2CC</td>
<td>±0.5 °C</td>
</tr>
<tr>
<td>1.16</td>
<td>Humidity output signal</td>
<td>4 to 20 mA for 0 to 100 %RH</td>
</tr>
<tr>
<td><strong>Temperature output signal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.17</td>
<td>H/DT, H/DT/5%</td>
<td>Thermistor 10 kΩ at 25 °C</td>
</tr>
<tr>
<td>1.18</td>
<td>H/DT/2CC</td>
<td>4 to 20 mA for -10 to +70 °C</td>
</tr>
<tr>
<td><strong>Supply Voltage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.19</td>
<td>H/DT, H/DT/5%</td>
<td>Thermistor 10 kΩ at 25 °C</td>
</tr>
<tr>
<td>1.20</td>
<td>H/DT/2CC</td>
<td>4 to 20 mA for -10 to +70 °C</td>
</tr>
<tr>
<td>1.21</td>
<td>H/DT, H/DT/2CC</td>
<td>12 to 36 Vdc</td>
</tr>
<tr>
<td>1.22</td>
<td>H/DT/5%</td>
<td>15 to 36 Vdc</td>
</tr>
<tr>
<td><strong>2 Mechanical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H/DT, H/DT/2CC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Duct probe</td>
<td>310 x 19 mm</td>
</tr>
<tr>
<td>2.2</td>
<td>Head</td>
<td>94 x 57 x 85 mm</td>
</tr>
<tr>
<td>2.3</td>
<td>Fixing centres</td>
<td>85 mm</td>
</tr>
<tr>
<td>H/DT/5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Technical Specifications

**Out side type Humidity & Temperature Sensor with display**

<table>
<thead>
<tr>
<th>SI No</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrical</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Humidity measurement range</td>
<td>0 to 99 %RH non-condensing</td>
</tr>
<tr>
<td>1.2</td>
<td>Temperature measurement range</td>
<td>-40 to +50 °C</td>
</tr>
<tr>
<td>1.3</td>
<td>Humidity element H/DT, H/DT/2CC</td>
<td>Resistance change through bulk polymer</td>
</tr>
<tr>
<td>1.4</td>
<td>Humidity accuracy</td>
<td>± 3 %RH within range 20 to 90 %RH including hysteresis, linearity and repeatability.</td>
</tr>
<tr>
<td>1.5</td>
<td>Temperature effect on RH</td>
<td>less than 0.11% per °C</td>
</tr>
<tr>
<td>1.6</td>
<td>Sensitivity</td>
<td>0.1 %RH</td>
</tr>
<tr>
<td>1.7</td>
<td>Hysteresis</td>
<td>Less than 1 %</td>
</tr>
<tr>
<td>1.8</td>
<td>Repeatability</td>
<td>0.5 %RH</td>
</tr>
<tr>
<td>1.9</td>
<td>Long term stability</td>
<td>Less than 1 % drift per year</td>
</tr>
<tr>
<td>1.10</td>
<td>Temperature element</td>
<td>Thermistor 10 kΩ at 25 °C</td>
</tr>
<tr>
<td>1.11</td>
<td>Temperature accuracy of sensor</td>
<td>± 1 °C</td>
</tr>
<tr>
<td>1.12</td>
<td>Humidity output signal</td>
<td>4 to 20 mA for 0 to 100 %RH</td>
</tr>
<tr>
<td>1.13</td>
<td>Temperature output signal</td>
<td>Thermistor 10 kΩ at 25 °C</td>
</tr>
<tr>
<td>1.14</td>
<td>Supply Voltage</td>
<td>12 to 36 Vdc</td>
</tr>
</tbody>
</table>

### Mechanical

<p>| Dimensions |
| H/OT | 180 x 85 x 57 mm |
| H/OT/RS | irregular |
| Mast diameter | 50 mm maximum (H/OT/RS) |
| Fixing Centres |
| H/OT | 85 mm |
| H/OT/RS | 58 mm (square) |</p>
<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Humidity measurement range</td>
<td>0 to 95 %RH non-condensing</td>
</tr>
<tr>
<td>1.2</td>
<td>Temperature measurement range</td>
<td></td>
</tr>
<tr>
<td>1.2a</td>
<td>H/ST</td>
<td>-10 to +40 °C</td>
</tr>
<tr>
<td>1.2b</td>
<td>H/ST/2CC</td>
<td>0 to +40 °C</td>
</tr>
<tr>
<td>1.3</td>
<td>Humidity element</td>
<td></td>
</tr>
<tr>
<td>1.3a</td>
<td>H/ST, H/ST/2CC</td>
<td>Resistance change through bulk polymer</td>
</tr>
<tr>
<td>1.3b</td>
<td>H/S/5%</td>
<td>Capacitance change across polymer</td>
</tr>
<tr>
<td>1.4</td>
<td>Humidity accuracy including</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hysteresis, linearity and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>repeatability.</td>
<td></td>
</tr>
<tr>
<td>1.4a</td>
<td>H/ST</td>
<td>±3 %RH (20 to 90 %RH)</td>
</tr>
<tr>
<td>1.4b</td>
<td>H/ST/2CC</td>
<td>±2 %RH (20 to 90 %RH)</td>
</tr>
<tr>
<td>1.4c</td>
<td>H/S/5%</td>
<td>±5 %RH (30 to 70 %RH)</td>
</tr>
<tr>
<td>1.5</td>
<td>Temperature effect on RH</td>
<td>Less than 0.11% per °C</td>
</tr>
<tr>
<td>1.6</td>
<td>Sensitivity</td>
<td>0.1 %RH</td>
</tr>
<tr>
<td>1.7</td>
<td>Hysteresis</td>
<td>Less than 1 %</td>
</tr>
<tr>
<td>1.8</td>
<td>Repeatability</td>
<td>0.5 %RH</td>
</tr>
<tr>
<td>1.10</td>
<td>Temperature element</td>
<td></td>
</tr>
<tr>
<td>1.10a</td>
<td>H/ST</td>
<td>Thermistor 10 kΩ at 25 °C</td>
</tr>
<tr>
<td>1.10b</td>
<td>H/ST/2CC</td>
<td>Platinum 100 Ω</td>
</tr>
<tr>
<td>1.11</td>
<td>Temperature accuracy of sensor</td>
<td></td>
</tr>
<tr>
<td>1.11a</td>
<td>H/ST</td>
<td>±0.5 °C</td>
</tr>
</tbody>
</table>
1.11 b H/ST, H/ST/2CC

1.12 Humidity output signal 4 to 20 mA for 0 to 100 %RH

1.13 Temperature output signal

1.13a H/ST Thermistor 10 kΩ at 25 °C

1.13b H/ST/2CC 4 to 20 mA for 0 to 40 °C

1.14 Supply Voltage

1.14a H/ST, H/ST/2CC 12 to 36 Vdc

1.14b H/S/5% 15 to 36 Vdc

2 Mechanical

2.1 Dimensions

2.1a H/ST, H/ST/2CC 86 x 86 x 35 mm

2.1b H/S/5% 85 x 85 x 37 mm

2.2 Enclosure Material Flame retardant (VO) ABS

2.3 Connectors

2.3a H/ST, H/ST/2CC 2 part screw terminals for 0.5 to 5 mm² cable.

2.3b H/S/5% Single part terminals for 0.5 to 5 mm² cable.

2.4 Weight

2.4a H/ST, H/ST/2CC 72 gm

2.4b H/S/5% 98 gm

3 Environmental

3.1 Ambient limits

3.1a Temperature -10 to +50 °C

3.1b Humidity 0 to 95 %RH non-condensing

SECTION 16

LIST OF MAKES

SCHEDULE OF MANUFACTURERS – HVAC WORKS

All the materials supplied under this contract shall be from one of the manufacturers listed below. No alternate Makes shall be accepted unless all the listed Makes are unavailable. Materials proposed from listed Makes also must fully comply with Detailed Specifications.

1. CHILLERS - HVAC  
BLUESTAR / CARRIER / CLI VET  
YORK / KIRLOSKAR / MCQUAY  
HITACHI / VOLTAS / DUNHAMBUSH / TRANE

CHILLER PACKAGE  
SNOWCOOL INDIA / BLUESTAR / CLI VET

PROCESS COOLING  
HITACHI / VOLTAS / DUNHAMBUSH / CLI VET

2. AIR HANDLING UNITS  
BLUESTAR / CLIVET-VTS (FAN RUGER / COMEFRI / NICOTRA)  
VOLTAS / ZECO / VAYHAN / SUVIDHA SAVIER  
ETA NOVAIR / FLAKT / LLYODS

3. FAN COIL UNITS  
BLUESTAR / ZECO / ETA / TRANE  
CARYAIRE - FLAKT  
VOLTAS,

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
4. CASSETTES UNITS
   - BLUESTAR
     - CARRIER
     - HITACHI
     - ZEN
     - DAIKIN
     - VOLTAS

5. HI WALL MINISPLIT
   - BLUESTAR
     - HITACHI / LG
     - VOLTAS
     - CARRIER

6. PUMPS
   - GRUNDFOS
   - /BEACON
   - ITT BELL GOSSETTE
   - ARMSTRONG / KIRLOSKAR
   - CRI

7. Fans (Centrifugal / Axial)
   - HITACHI / LG

8. Air Distribution Devices
   - AIR MASTER
   - CARRYAI RE
   - AIRFLOW
   - RAVISTAR/COSMOS

9. GI Sheet
   - SAIL / JINDAL / TATA

10. Duct Supports
    - HITECH / HILTI

11. Expansion Valves
    - SPORLAN
    - DANFOSS

12. Motors
    - ABB
    - SIEMENS/KIRLOSKAR
    - CROMPTON GREAVES

13. Electrical Components
    - TELE MECHANIC
    - SIEMENS
    - MARLIN GERIN L
    - & T
    - HAVELL

14. Copper Pipes
    - RAICO/MANDEV/TOTALINE
    - KWALITY

15. PLC/VFD/BMS & INSTRUMENTS
    - SEIMENS
    - JOHNSON
    - HONEYWELL
    - SAUTER
    - DANFOSS
    - ABB – AUTOMATED LOGIC

16. Insulation
    - ARMAFLEX/K-FLEX/VIDEO
    - FLEX/SUPREME/TWIGA
    - (PIPES/DUCTS/WALLS/ROOF)

17. Cables
    - CCI
    - POLYCAB
    - FI NOLEX
    - HAVELL
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.</td>
<td>Pipes</td>
<td>TATA / JINDAL / PRAKASH SURYA</td>
</tr>
<tr>
<td>19.</td>
<td>Butterfly / Ball Valves</td>
<td>AUDCO ADVANCE INTERVALVE BONOMI / CRI</td>
</tr>
<tr>
<td>20.</td>
<td>NR Valves</td>
<td>AUDCO ADVANCE INTERVALVE BOSS SHAKTI</td>
</tr>
<tr>
<td>21.</td>
<td>Y STRAINER</td>
<td>EMERALD/SA NT LEADER ADVANCE/</td>
</tr>
<tr>
<td>22.</td>
<td>ALL Instruments (Including Pressure &amp; Temp Gauges)</td>
<td>AMTROL DYWER – ALM/TAYLOR SIEMENS/GURU/FIEBIG/BIPSON HONEYWELL/FIEBIG ANERGY</td>
</tr>
<tr>
<td>23.</td>
<td>CABINET TYPE EXHAUST FANS</td>
<td>KRUGER / SYSTEMAIR - SEVCON NICOTRA / NADI / GREENHECK</td>
</tr>
<tr>
<td></td>
<td>SISW CABINET TYPE FANS</td>
<td>KRUGER / SYSTEMAIR-SEVCON NICOTRA / NADI / GREENHECK</td>
</tr>
<tr>
<td>24.</td>
<td>INLINE / PROPELLER FANS</td>
<td>KRUGER / SYSTEMAIR – SEVCON NICOTRA / NADI / GREENHECK GEC</td>
</tr>
<tr>
<td>25.</td>
<td>AIR COOLED CONDENSING UNITS</td>
<td>BLUESTAR LG/ETA/ITACHI CARRIER VOLTAS</td>
</tr>
<tr>
<td>26.</td>
<td>SPRING ISOLATORS</td>
<td>HWAD HOPEDEX INDUSTRIES</td>
</tr>
<tr>
<td>27.</td>
<td>AIR FILTERS</td>
<td>AIR TECH UCO ARW DYNA CAMFILL AAF/COSMOS</td>
</tr>
<tr>
<td>29.</td>
<td>PRECISION A C</td>
<td>STULZ / CITEC / HIROSS</td>
</tr>
<tr>
<td>30.</td>
<td>V A V TERMINAL BOXES</td>
<td>BELIMO / BARCOL – AIR SAUTER</td>
</tr>
<tr>
<td>31.</td>
<td>COOLING TOWERS</td>
<td>MIHI R/PAHARPU R/NEWTECH</td>
</tr>
<tr>
<td>32.</td>
<td>BALANCING VALVES</td>
<td>T&amp;A / FLOWCON / OVENTROP</td>
</tr>
</tbody>
</table>
33. CLOSED EXPANSION TANK ITT / AMTROL / ANERGY
34. AIR SEPARATOR ITT – ROLAIRTROL/ ANERGY / AMTROL
35. 2 WAY VALVES MOTORISED HONEYWELL / SIEMENS
36. M S CONDUITS BHARAT / GUPTA / GV
37. WELDING ELECTRODES ADVANI / ESSAB
38. COMBINED SMOKE & FD CARYAIR/ GREENHECK /AIRMASTER
39. FD ACTUATOR BELI MO / JUVINTA
40. FACTORY DUCTS ROLASTAR / ZECO/NUTECH
41. SPIRAL DUCTS GP SPIRO / WESTERN DUCTS
42. FACTORY FABRICATED PLENUMS AI RMATER/ ROLASTAR/CARYAIR
43. FLEXIBLE DUCTS UPTWIGA/CARYAIRE/ NUTECH
44. OPTIC FIBRE CABLES AVAYA / AMP / LAPP / BELDON
45. FIRE DAMPER RAVISTAR / AIRMASTER
46. 3-WAY MIXING VALVE AND CONTROL HONEYWELL/JOHNSON/DANFOSS
47. FLOW SWITCH RAPID CONTROL /HONEYWELL/ JOHNSON

HVAC - ELECTRICALS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Items Descriptions</th>
<th>Make of Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ACB</td>
<td>ABB / Schneider / Siemens/L &amp; T</td>
</tr>
<tr>
<td>2</td>
<td>MCCBs / MPCBs/DBs</td>
<td>ABB / Schneider / Siemens / Legrand / L&amp;T / Havells/Merlin Gerin</td>
</tr>
<tr>
<td>3</td>
<td>Contactors and O/L Relay</td>
<td>ABB / Schneider / Siemens</td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
<td>Brands/Models</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Load Monitors / Controller</td>
<td>Ducati / Electrex / Enercon</td>
</tr>
<tr>
<td>5</td>
<td>MCBs</td>
<td>ABB / Schneider / Siemens / Legrand / L&amp;T / Havells</td>
</tr>
<tr>
<td>6</td>
<td>Capacitor (Heavy duty MPP Gas filled)</td>
<td>Siemens (EPCOS)</td>
</tr>
<tr>
<td>7</td>
<td>CTs and PTs</td>
<td>Kappa / Siemens</td>
</tr>
<tr>
<td>8</td>
<td>Control Switches</td>
<td>Kaycee / Siemens / Salzer/L&amp;T</td>
</tr>
<tr>
<td>9</td>
<td>ELR / Earth Fault Relay</td>
<td>JVS / Alstom / Prok DVS</td>
</tr>
<tr>
<td>10</td>
<td>Protective Relays</td>
<td>JVS / Alstom / SEG / Approved equivalent</td>
</tr>
<tr>
<td>11</td>
<td>Push Buttons</td>
<td>ABB/Siemens / Teknic / Schneider/GE</td>
</tr>
<tr>
<td>12</td>
<td>Indicating lamps (LED type)</td>
<td>Siemens / Teknic / Schneider/L&amp;T</td>
</tr>
<tr>
<td>13</td>
<td>Wires (FRLS)</td>
<td>Farcom / RR Kabel / Anchor</td>
</tr>
<tr>
<td>14</td>
<td>Lugs. Glands</td>
<td>Dowells / SMI / Comet/Lotus/Multi</td>
</tr>
<tr>
<td>15</td>
<td>Terminals</td>
<td>Elmex / Wago – Finger touch proof</td>
</tr>
<tr>
<td>16</td>
<td>Ferrules</td>
<td>Mayfair</td>
</tr>
<tr>
<td>17</td>
<td>Busbar supports</td>
<td>Powermat or approved equivalent</td>
</tr>
<tr>
<td>18</td>
<td>Energy Meter</td>
<td>Electrex / Enercon</td>
</tr>
<tr>
<td>19</td>
<td>Name plates</td>
<td>Screen printed acrylic</td>
</tr>
<tr>
<td>20</td>
<td>Switchboard manufacturer</td>
<td>CPRI APPROVED</td>
</tr>
<tr>
<td>21</td>
<td>Starter/Switches/Contractors</td>
<td>L &amp;T/Siemens/Crompton</td>
</tr>
<tr>
<td>22</td>
<td>Switch Board</td>
<td>Khokar/Seimens/GE / power Control/Advance/Pragati</td>
</tr>
<tr>
<td>23</td>
<td>Time delay Relay/Limit Switch</td>
<td>L &amp;T/Siemens/Crompton</td>
</tr>
<tr>
<td>24</td>
<td>Single Phase Preventor</td>
<td>L &amp;T/Siemens/Crompton/GE</td>
</tr>
<tr>
<td>25</td>
<td>Senser/Thermostate</td>
<td>Siemens/Honeywell/Johnson/s/Danfoss</td>
</tr>
<tr>
<td>25</td>
<td>CABLE TRAYS</td>
<td>Profab/Patni/Elcon</td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
PART IV

COMPRESSED AIR SYSTEM

CRANES
1.0 SCOPE OF WORK:

The scope of work includes supply, installation, testing and successful commissioning and handing over of complete compressed air Pipeline Work.

SCOPE: This specification covers the general requirements for on site shop fabrication, erection, commissioning, testing and cleaning of compressed air pipelines. All pipe work shall be in conformity with the requirements of the applicable drawings and specifications. Where specific details of fabrication are not shown on the drawings or specified herein, fabrication shall be in accordance with BS 3351/ ASA B 31.3

Piping shall also comply with applicable state, local or other Governmental laws and codes. All work shall be performed in accordance with the best modern practice for this type of work and shall be of highest quality workmanship.

Any deviations from these specifications, must have the approval of Consultant / Owner.

LIST OF BUILDINGS:

2. 19/1 - ARMAMENT AGGREGATE O/H SHOP (Shop: 206)
3. 20/1 - MECHANICAL & AVIONICS AGGREGATE O/H SHOP (Shop: 204 & 207)
4. 21/1 - TEST STATION FOR HYDRO-PNEUMATIC FUEL AGGREGATES (Shop: 204B)
5. 22/1 - LANDING GEAR O/H SHOP (Shop: 205)

11 DETAILED SCOPE OF WORK FOR PIPING WORK:

(s) No changes without prior approval
(t) Site safety, security and cleanliness
(u) Project schedule
(v) Discrepancies / interferences resolved before installation.
(w) Supply of piping materials to work site/shop, fabrication and erection, testing and commissioning of all piping system in accordance with the specification.

(e) Fabrication and erection of pipe supports, brackets, as per pipe support standards and drawings and instructions of Engineer-in-Charge.

2. The contractor shall also bear the cost of repair, changes, replacement, etc. due to noncompliance with the standards, codes or due to disregard of instructions given by Engineer-in-Charge.

(ix) It is the responsibility of the contractor to take care of all the material brought inside the HAL until the time of handing over to the Owners.

(vii) Any other items as required in the drawings/specifications are to be fabricated and erected from the available materials.

a. All incidental jobs connected with Industrial piping work such as cutting chasing in concrete and brick work and making good cutting/drilling holes through walls, floors and grouting for fixing of supports etc. complete.

(i) The contractor for this work shall be required to work in Co-operation with other civil engineering, Electrical etc Contractors should give them all reasonable assistance and help for the execution of the work in an efficient manner as directed. Any work done without regard or consultation with other trades shall be removed by the Contractor without additional cost to the Owner, to permit the proper installation of all other works as desired by the Architects.

(ix) Repair all damages done to the premises as a result of this installation and removal of all debris left by those engaged for this installation to the satisfaction of the Owner.
12 PIPE JOINTS:

In general joints shall be butt welded as specified in the applicable valve and piping specifications, with flanges and butt weld fittings used where required. Flange faces shall be in a plane perpendicular, true and square to the centerline of the pipe to which they are welded. Bolts on flanged joints shall be drawn up to provide even and adequate pressure on gaskets.

WELDING

Fabricated piping system shall be erected as detailed on piping layout drawing and as advised by the consultant and / or owner. The contractor shall provide adequate field joints bearing in mind the fact that there may be variations in locations of equipments, equipment nozzles, inserts, structures, etc. but not limited to the aforesaid contingencies only. In certain cases site measurement may have to be taken before commencement of fabrication.

Flange joints shall be used at connections to equipments, valves, flanged fittings and wherever required for ease of erection and maintenance as indicated in the drawings.

13 MEASUREMENTS:
The measurements (for the payment purpose) shall be considered as per actual laid quantity. The mode of measurement shall be in running meters for the compressed air pipeline including fittings such as bends, elbows, tees, unions, nuts, bolts, washers, gaskets, nipples, expanders/reducers complete with adequate supports, and wrapping/ coating for the underground pipeline.

Measurements (for the payment purpose) of the Flanges, Long Radius bends, Isolation (Ball) valves, Filters, Pressure gauges, Drip leg drains, Quick fix couplers with plug, Air compressor, Air dryer and Air receiver shall be considered as per the actual quantity used.

14 RESPONSIBILITY

(d) DRAWINGS

The drawing enclosed herewith is the guidance to the contractor. The contractor shall submit shop floor drawings for the consultant approval. The contractor should execute the pipeline on the drawings enclosed. After the completion of the test and handing over the work, the contractor shall submit 3 sets of hard copies of as-built drawings. If required, draft copies of the same shall be approved by the consultant.

DRAWING/INFORMATION REQUIRED FROM SUCCESSFUL TENDERER WITHIN 15 DAYS AFTER AWARD OF WORK:

Bar chart showing engineering, manufacturing and dispatch of each equipment and erection services.

Drawing, literature and technical particulars of all bought out items.

Schedule for valves and piping material.

(j) PAINTING

All piping, furnished under this work shall be properly painted with two coats of a synthetic enamel paint over a coat of primer after installation as per IS Code. Arrow marks for indicating flow direction and stenciling to be done as per Good Engineering Practice.

Colour Code of the piping shall be SKY BLUE

(b) SCAFFOLDING:

All scaffolding and ladders required for the proper execution of the work shall be in the scope of the contractor.

(c) QUALITY OF MATERIALS AND GENERAL STANDARDS OF WORK

The contractor under this contract commits himself to use the first class materials and assumes full responsibility for the quality of all material incorporated or brought for incorporation in the work. The work shall be executed in accordance with the best engineering practice and as per directions of the consultant.

d) SAMPLES SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

The samples of all the materials to be incorporated in the work shall be furnished to the consultant and got approved prior to bulk procurement. Necessary certificates / documents required for the bought out items are to be produced.
c) GUARANTEE
The contractor shall guarantee the material and workmanship of the entire system for a period of 12 months from the date of commissioning or 18 months from the date of the supply of the items and hand over necessary documentation.
Guarantee/test certificates of equipment from suppliers/manufacturers/contractor shall be handed over to the Owner.
In case of any defective equipment/material/workmanship, the contractor shall rectify/modify/replace the defective item at free of cost. Any delay on the part of the contractor in doing so, gives the owner the right to get the defect rectified through other agency and the cost for the same shall then be borne by the contractor.

(u) INSTRUCTION MANUAL/COMPLETION DRAWINGS/TRAINING
The contractor shall furnish detailed instruction and operation manual in quadruplicate. The contractor shall also furnish detailed completion drawings as soft copy (in AutoCAD format) and hard copy on tracing sheet. The drawings shall be inclusive of control schematic, if any. The contractor shall train the Employer's personnel in the operation and maintenance of the system.

1. TESTING
The Contractor shall arrange to test the entire system as per the procedure enumerated under particular specifications, after the erection is completed. The test reports shall be duly signed and sealed by foreman and subsequently submitted to the Owners and Architects in triplicate. If the results of the tests are not found to be satisfactory by the Owners and Architects, necessary rectification shall be done until the test results are found to be satisfactory. The installation shall be deemed to be completed only after successful completion of the tests.

(f) TESTING PROCEDURE:
All piping shall be hydraulically tested for 1.5 times of working pressure after completion of erection to check for leakages. The water shall be held for 6 hours and any leakages found are to be rectified, the water has to be drained out completely, flush out the entire pipe line with the compressed air continuously to remove all traces of the moisture/water traces if any left with in the pipeline.
The pipeline where hydraulic testing is not practically feasible there it shall be pneumatically tested at 1.5 times of working pressure after completion of erection to check for leakages.

e) PRE-DESPATCH INSPECTION:
Pre-dispatch inspection to be arranged for representatives of owner for the items like Air compressor, Air dryer and Air Receiver at the suppliers work. Where the performance of the equipments can be checked. The responsibility lies with the contractor for successful installation and commissioning of the equipments towards entire satisfaction to the owner at the site. Final acceptance shall be after entire satisfaction to owner.

2. CUTTING AND WELDING PROCEDURE:

21 CUTTING:
Pipe and plates shall be cut as per the standard engineering practice by suitable means. No Electric metal arc cutting shall be allowed.
All edges cut by oxy-acetylene shall be cleaned of impurities prior to welding joints.

22 CUTTING TOLERANCE SHALL BE AS FOLLOWS:

a) For pipe or plates connected at both ends to - 1mm
b) Elsewhere to - 3mm

2.3 EDGE PREPARATION OF PIPES FOR WELDING:
The edge preparation for welding of pipes more than 1/2" wall thickness shall be done by flame cutting and followed by grinding. Cut faces shall not have cracks or irregular. Edge preparation of pipe diameters below 1/2" wall thickness shall be done by Grinding Machine.
Sharp edges, rust of cut edges, notches, and irregularities fissures due to faulty cutting shall be chipped, grounded over the length.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Project: “Civil, Electrical and other utility services for package -Civil- II (Rotable complex)

VOLUME –II. TECHNICAL SPECIFICATIONS FOR TENDER NO.NK/FW/CAP-ROH-577/2010-11

2.4 WELDING PROCEDURE:
Welding shall be carried out only by fully qualified welders as tested and approved by the architects / consultants. Any test carried out in presence of either the architects / consultants or their representative or the inspectors shall constitute a right by them for such tests and the cost involved thereon shall be borne by the contractor himself.

When welding is carried out in open air, steps shall be taken to protect the place of welding against wind, rain or moisture, the welding electrodes and parts being welded shall be dry.

Prior to the commencement of the welding, welder has to check the root gaps for all butt welds for single or double 'V' as per IS: 823. The welding joints shall be allowed to cool slowly.

For multilayer welding, before welding the following layer, the formerly welded layer shall be cleaned to metal bright by light chipping and wire brushing. Packing strips shall not be allowed i.e., all slag shall be removed.

Only welding generator / rectifier shall be used for welding.

Welder Qualification:
2G welding position qualification test will be conducted in presence of Consultant / PMC / Client.

Electrodes: Welding electrodes with a suitable coating shall be in accordance with applicable IS and of a recognized quality of reputed manufacturers.

INSTALLATION

Above Ground piping – All piping shall be erected as shown in the drawings and in accordance with the specifications so as to conform to the applicable codes and engineering design.

Arrangement drawings shall show general location and should indicate special dimensions, locations of valves, fittings etc wherever critical.

Slopes of piping specified on drawings shall be maintained.

INSIDE SHOP PIPELINE: The compressed air pipeline inside the shops should be laid along the walls with necessary brackets and supports. Adequate pipe supports, anchors and guides for piping shall be provided. The fabrication shall be as per the best engineering practice as laid down in the IS.

BRACKETS / SUPPORTS:
All brackets / supports shall be made out of suitable M.S. rolled steel sections, bar and strip with C.I. washers, helical springs, sling eyes, U bolts etc fixed on the walls or hung from the slabs/ roof truss by MS rods / angles including grouting / welding or fixed to special insert plates (already provided in the construction) or fixed to special inserts as the case may be including fasteners, bolts, anticorrosive and color painted etc complete as required and / or by suitable means as per best engineering practice and

25 WELDING INSPECTION:
All weld joints shall be DP tested after completion of the welding for blow holes, cracks etc.,

2.6 SOCKET WELD :
Allowable diameter range:
Threaded ≤ 2NB
Welded > 2NB

Material of Construction : As per IS: 1239
Type : ERW
Class : Heavy

3. TECHNICAL SPECIFICATIONS:

31 PIPES:
Material : Mild Steel

3.2 FLANGES:
Material : Mild Steel
Material of Construction : As per IS: 1239 Part:II
Type : SORF
Standard : As per ANSI B16.5
Rating : 150 #

3.3 FITTINGS:
Material : Mild steel
Material of construction : As per IS:1239 Part-II
Standard : As per ANSI B 16.9
Class : Heavy

3.4 GASKET:
Material : Neoprene
Thickness : 3.0mm
Standard : As per ANSI B16.21
Sizes : To match RF 1 50# rating flanges

3.5 BOLTS & NUTS:
Type : Hexagonal
Material : Carbon Steel
Standard : As per IS:1364 & 1367

3.6 ISOLATION VALVE:
Type : Ball Valve (Make: Audco)
Material of construction : Forged carbon steel from 15 to 40 mm NB
Cast carbon steel from 50 to 150 mm NB
Body : (<40NB) : ASTM A 105
(>40NB) : ASTM A 216 Gr. WCB
Ball : AISI 304
Stem : AISI 304
Seat & seal : PTFE
Ends : Flanged to ANSI B16.5, 150#
Lever : Carbon Steel with PVC Sleeve
Hydro Test Pressure : Body : 30 Kg/cm²
Seat : 21 Kg/cm²

3.7 PRESSURE GAUGE:
Type : Bourdon tube Pressure gauge with shut off cock.
Dial size : 150 MM
Size : 0-10 kg/cm² G.
Mounting : Direct Mounting
Housing : Weather proof housing
Pointer : Micro type adjustable pointer
Case : Stainless Steel

3.8 DRIP-LEG DRAIN:
Inlet Port : 1/2” BSP Female.
Max. Pressure : 10 Kg/cm²
Body : Carbon Steel
Bowl : Transparent Polycarbonate bowl.
Draining : Automatic

SIGNATURE OF TENDERER WITH SEAL
EMPLOYER

39 QUICK FIX COUPLING:
Quick Release Coupling size: As per BOQ
Construction: Poppet Type
Mounting (Ends): Threaded
Material: Brass with Nickel Plating
Seal: NBR,
Working pressure: 8 kg/cm² G
Check valves: Single check valve in socket., with heavy duty
Sleeve with NBR Rubber Seal.
End Connections: Socket: Threaded & Plug
Plug: Feasible for Rubber hose pipe connection.

Important Note: One sample has to be approved from M/s HAL prior to bulk supply.

4. LIST OF APPROVED MAKES:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>DESCRIPTION</th>
<th>MAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PIPES - MS</td>
<td>TATA / JINDAL</td>
</tr>
<tr>
<td>2</td>
<td>PIPE FITTINGS – MS</td>
<td>BHARAT FORGE / SANGHI IMPEX / METAL UDYOG / equivalent - Reputed Make</td>
</tr>
<tr>
<td>3</td>
<td>ISOLATION VALVE</td>
<td>AUDCO</td>
</tr>
<tr>
<td>4</td>
<td>PRESSURE GAUGE</td>
<td>H-GURU / WIKA / FEIBIG or equivalent - Reputed Make</td>
</tr>
<tr>
<td>5</td>
<td>PRESSURE REGULATOR</td>
<td>JANATICS / KUSHAKO / SPIRAX / AUDCO / LEADER</td>
</tr>
<tr>
<td>6</td>
<td>GASKET</td>
<td>CHAMPION</td>
</tr>
<tr>
<td>7</td>
<td>QUICK FIX COUPLINGS</td>
<td>TECHNODRIVE (PNEUMAX) / PIONEER / SPIRAX / JANATICS or equivalent - Reputed Make</td>
</tr>
<tr>
<td>8</td>
<td>DRIP LEG DRAIN</td>
<td>PARKER / NORGREN / SPIRAX / JANATICS or equivalent - Reputed Make</td>
</tr>
<tr>
<td>9</td>
<td>BOLTS / NUTS</td>
<td>SKANDA / ZION / TVS or equivalent - Reputed Make</td>
</tr>
<tr>
<td>Description of the Equipment</td>
<td>Electrically Operated Traveling Cranes (SG/DG Under slung EOT Cranes / Monorail)</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Single Under slung, double Girder over head and Monorail</td>
<td></td>
</tr>
<tr>
<td>Design criterion must</td>
<td>Crane must be designed to lift 110% of the rated capacity and function normally i.e., according to its regular functions.</td>
<td></td>
</tr>
<tr>
<td>Scope of Supply</td>
<td>Design engineering, manufacture, fabricate, assembly, testing, packing, delivery, installation and commissioning of the equipment at site as per this specification along with the down shop lead system. The constructions, its components, design, testing and commissioning of the crane shall confirm to IS 3177 class II medium. The crane must be equipped with adequate safety devices.</td>
<td></td>
</tr>
<tr>
<td>Crane Bridge</td>
<td>Steel conforming to IS: 2062 or equivalent should be used in the manufacture of the above Box / RSJ with capping channel type Bridge Girder. In case, test certificates are not available, test pieces should be taken out at random from the lots and should be tested for chemical composition /properties and submission of reports. 100% reliability of the main butt-welded joints is to be ensured. All Butt welds for main girders for load bearing to be D.P. inspected. Girders are to be cambered for smooth running of trolley. Crane Girders of box type construction, made out of IS: 2062 plates, minimum plate thickness is to be 5 mm for indoor duty and 1 mm corrosion allowance will be provided for outdoor duty cranes. The tension joints of the Bridge Girder should be 100% radiographed and other butt welds should be checked for dye penetration check. The box girders should be constructed in a way to eliminate accumulation of water or oil inside them.</td>
<td></td>
</tr>
<tr>
<td>Gantry Girders</td>
<td>Gantry Girders / Rails (or both gantry girders and rails) should be Supplied, erected and aligned by the PEB Vendor in co-ordination with the Architect and or Crane vendor.</td>
<td></td>
</tr>
</tbody>
</table>

Note:

(x) Gantry Girders / Rails or both (as applicable depending on the type of crane): The PEB vendor to fabricate the Gantry Girders/ Rails from required size of EN8 / M.S. bright steel should be supplied, fixed and should be aligned and welded to ensure the smooth running of the cranes. The gantry girders / rails (as applicable) must be mounted such that the span does not vary with more than plus minus 3 mm for crates up to 15 m span and plus minus 5 mm for larger spans. The difference in height along the runway should be less than 0.3 % of runway length. The difference in height between two rails (measuring points opposite each other should be less than 0.15 % of span. The PEB vendor may be required to take the co-ordination from the crane vendor for proper size and alignment.

(y) Catwalk: PEB Vendor shall supply, fabricate, and erect the cat walk along the gantry (crane runway) as per requirement including the access ladder from ground to catwalk. The material shall conform to IS:2062 or equivalent.

End Carriage                | End carriages shall be manufactured from heavy structural steel or

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
welded from high tensile steel plates. The carriages are to be of sturdy design and robust construction fabricated from steel plates confirming to IS: 2062. Safety lugs, rail sweeper, jacking pad and safety buffers to be provided.

Platform

a). Small platform for Cranes on LT drive side is to be provided on one side of the Crane girder. Minimum width of the platform to be 600mm. The platform should have two-tier hand railing in tubular construction complete with toe guards.

b). Full length platform along the side of the crane girder for the cranes having the type construction & span above the m

c). Platform at both ends for the cranes having height of above 6m and span less than the m

Maintenance cage / compartment for Hoist & DSL to be provided on both side of the crane. Or any arrangement like a single person can sit and can do maintenance activity of hoist.

Variable frequency drive & Load display not required.

**SINGLE GIRDER UNDER SLUNG EOT CRANE:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Capacity in Tons</th>
<th>Qty in No's</th>
<th>Speed (Micro Speed control) in M/min</th>
<th>Span Max in M</th>
<th>H.t of lift(approx in m)</th>
<th>Long travel(Approx)in m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building – (1 9/1 )Shop 206</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoist</td>
<td>Cross Travel</td>
<td>Long travel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section for testing of beam holders launching and catapulting devices</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>15</td>
<td>20</td>
<td>17.5</td>
</tr>
<tr>
<td>Section for Overhaul of beam holders, launching and catapulting devices</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>15</td>
<td>20</td>
<td>23.5</td>
</tr>
<tr>
<td>Section for vibration testing</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>7.5</td>
</tr>
<tr>
<td>Section of Overhaul of artillery armament</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>7.5</td>
</tr>
<tr>
<td>Section of Preservation and Packing</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>7.5</td>
</tr>
<tr>
<td>Section for de preservation and washing</td>
<td>0.5</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>5.5</td>
</tr>
<tr>
<td>Building - (20/1)</td>
<td>Shop – 204</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section for depreservation and preliminary washing by benzene and kerosene</td>
<td>0.5 1 5 10 15 5.5 4.1 14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section for dismantling of aggregates</td>
<td>0.5 1 5 10 15 5.5 4.1 14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section for acceptance of aggregate in overhaul</td>
<td>0.5 1 5 10 15 5.5 4.1 8.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building - (21/1)</th>
<th>Shop – 204</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premises for vacuum pumps</td>
<td>2 1 5 10 15 5.5 4.1 8.5</td>
</tr>
<tr>
<td>Section for Preservation</td>
<td>0.5 1 5 10 15 8.5 4.1 8.5</td>
</tr>
<tr>
<td>Section for Packing</td>
<td>0.5 1 5 10 15 5.5 4.1 8.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building - (22/1)</th>
<th>Shop – 205</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section for preliminary washing</td>
<td>1 1 5 10 15 6 6.9 11.5</td>
</tr>
<tr>
<td>Section for preservation and packing</td>
<td>1 1 5 10 15 6 6.9 11.5</td>
</tr>
<tr>
<td>Section for final washing</td>
<td>1 1 5 10 15 6 6.9 11.5</td>
</tr>
<tr>
<td>Store of articles, received for overhaul</td>
<td>1 1 5 15 20 17.5 6.9 35.5</td>
</tr>
<tr>
<td>Section of testing of struts</td>
<td>1 1 5 15 20 17.5 6.9 35.5</td>
</tr>
</tbody>
</table>

**DOUBLE GIRDER OVERHEAD EOT CRANE:**

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**
ITEM | Capacity in Tons (according Dwg) | Qty in No's | Speed (Micro Speed control) M/min | Span Max in M | H.t of lift (approx in m) | Long travel (Approx in m)
---|---|---|---|---|---|---
Building – (25/1) | Hoist | Cross Travel | Long travel
---|---|---|---
5 | 1 | 5 | 15 | 20 | 19.5 | 7 | 23.5

MONORAIL UNDER SLUNG EOT CRANE:

ITEM | Capacity in Tons (according Dwg) | Qty in No's | Speed (Micro Speed control) M/min | Span Max in M | H.t of lift (approx in m) | Long travel (Approx in m)
---|---|---|---|---|---|---
Building (21/1) SHOP -204 | Hoist | Cross Travel | Long travel
---|---|---|---
Box - 5 | 0.25 | 1 | 5 | -- | 10 | 0 | 4.1 | 5.5

COMMON SPECIFICATION

1. Class / Duty: Class II medium duty AS PER IS 3177 / 807 / 3938
2. Service: INDOOR
3. Installation: The tracks designed to hung from roof structure
4. Permissible deflection (mm): 1/900 of the span
5. Bridge girder construction: RSJ with Capping Channel / BOX Type as per design. Trolley shall run on top of the girders.
6. Finished Floor level to top of Rail (mm):
7. End Clearance (mm): 300
8. Head Room from rail top to bottom of roof truss (mm)/ RC Cross Beam (mm): 1500 (minimum)
9. Environment: Clean
10. Ambient temperature in the building: 15 to 40º C
11. Material Handled: :
12. Method of Control: Pendent moveable along the span
13. Location of Control: End of Crane and on Hoist
14. Type of Control: 2 speed All motions
15. Runway Conductors: Figure eight insulated type
## Motors

1. The motors should be crane duty motors of reputed makes like Crompton Greaves/ Bharat Bijlee etc Electric motors for all the motions are to be totally enclosed, TEFC / TESC Sq. Cage induction crane duty motors with Class-F insulation and protected with IP-54 /55 protection. All the motors will be S4 duty with 40% C.D.F; 3 Phase, 415V; 50 Hz for A.C. Supply.

2. For travel motions, standard geared brake motors/ conical rotor motors may be provided.

3. The motor should generally conform to IS: 325 – 78 (latest). The supplier should specify the Horse Power of Hoist, Cross Travel and Long Travel Motors, indicating the safety margin included.

4. The winding should be copper wire specially insulated and impregnated to withstand moist tropical climate.

5. Horse Power for the motors should be computed as per Appendix D of IS: 3177. The ratings of the motors in HP/KW should be specified. The frame size of motor should be indicated in the offer and it should take into account 45°C ambient temperature and voltage of 415 + 10%.

6. All motors should be provided with insulation of class “F” for stator and class “F” for rotor. The maximum permissible winding temperature measured by resistance method should not exceed 115°C and 135°C respectively.

7. The pull out torque of the motors at rated voltage and frequency range should be as per IS: 3177-77.

8. Type and routine test charts of the motors selected should be submitted with the equipment.

9. The terminal box should be provided on the top or side of the motor for easy accessibility. The terminals should be large enough with spaces to accommodate aluminium conductor cables if necessary. The cable sizes should be decided after considering de-rating due to grouping and ambient temperature of 45°C.

## Brakes

1. Electromagnetic fail safe D.C operated brake or conical brake shall be provided for the Hoist. For the travel, electromechanical centrifugal brakes / conical brakes / disc brakes may be provided for smooth operation.

2. All brakes should be capable of braking the respective movements effectively at various speeds and conditions. The brakes shall be of reputed makes like Pethe / Speed O control / Electromag or equivalent.
### Wheels

1. The Crane wheels shall be single flanged or suitable as per safe design with straight tread and shall be of Solid forged carbon steel wheels having the rolling surface and flanges hardened to a minimum hardness of 280-300 BHN / or spheroidal graphite cast iron with hardness of 250-300 BHN or alloyed steel with hardness of 45-55 HRC. Wheels are to be fitted with anti friction bearings. Minimum clearance on each side of wheels shall be 5 mm for C.T. and L.T. Wheels. and shall be mounted in anti friction roller bearings housed in ' L ' shaped bearing brackets. The bearing housing shall be designed for easy removal of wheels and bearings for maintenance.

2. The wheels shall be capable of taking up mis - alignments in span as specified. Wheel rim shall be heat treated to have a hardness of as given above on the rolling surface and flanges to a depth not less than 10 mm with a smooth pass to the non-hardness zone. The supplier should specify the diameter of wheels.

### Rope Drum

1. Rope drums shall be designed to withstand the compressive stresses caused by the wound-on rope and the bending stress due to beam action of the drum.

2. The hoisting rope drums are to be welded construction, duly fabricated from M. S. plate and stress relieved or from heavy walled seamless tubing. The rope drum shall be double-flanged type. The rope drum having left and right hand spiral grooves duly machined to the correct depth, radius and angle to ensure smooth rolling of the wire rope. The steel shall be IS: 2062-1996 quality. The rope drum shall be stress relieved after fabrication. “T” joint shall be radio graphically tested.

3. The rope drum shall be designed to take the entire length of the rope in single layer and should have machined grooves for winding the rope.

4. The length of the drum shall be such that it will have minimum two full turns of rope at the lowest position of the hook and at least one spare groove for each lead of rope with the hook at its highest position. Each rope end shall be clamped with minimum two clamping wedges with at least 2 numbers of bolts on each clamping arrangement.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5</strong></td>
<td><strong>Wire Rope &amp; rope guide</strong></td>
<td>Hoisting wire ropes should be extra flexible type, made from improved best plough steel, 6 x 36 FMC or suitable construction. The wire rope should confirm to IS: 2266 / 1970. High tensile hemp cored and galvanized of required diameter and construction with right hand lay should be provided. Rope guide shall be precision machined, wear resistant, heavy duty to suit rope drum grooves and maintain the rope in the grooves. No. of falls for 1 to 0.5 T CRANE is 2 and for 2 to 5 T CRANE is 4.</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td><strong>Gearing</strong></td>
<td>All the gears shall be machine cut hardened and profile ground and shall confirm to relevant Indian Standard. All the gears shall be of cast or wrought steel or forged from medium carbon alloy steel and suitably heat-treated. Teeth shall be machine cut, suitably hardened and tempered and shall conform to AGMA or IS 4460. Difference of hardness of pinion and gear must not be less than 20 BHN. The gearboxes to be made out of M.S. Fabricated body, CI body duly stress relieved, enclosed type, oil tight, dust proof. The boxes should be generally provided with lifting lugs, location dowels, breather vent, drain plug, deep stick/oil level indicator. All gearboxes shall be in totally enclosed construction. The gearboxes are splash lubricated and balance crane components with independent lubrication system, with provision of grease nipples at suitable places or advance lubrication system as per latest trend if any. BEARINGS: All the bearings provided shall be anti-friction ball/roller bearings. Life of the bearings shall conform to Clause 7.3 of IS: 3177. Bearings shall be of reputed makes like SKF / FAG/ TATA / ZNL / ZKL / URB or equivalent. COUPLINGS: For efficient power and torque transmission and to compensate all type of miss-alignments to compensate end and axial movement of the coupled shafts, there should be a provision of geared flexible coupling for all couplings at all coupled up connections.</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td><strong>Buffers</strong></td>
<td>Suitable buffers shall be fitted on the four corners of the Crane. Buffers shall be rigidly bolted in the place, preferably along with center line of the Gantry rail. All buffers shall have sufficient energy absorbing capacity to stop the crane in either direction when Traveling at a speed of at least 40% full load rated speed. Crane buffers shall have a contact surface or not less than 125 mm in diameter.</td>
</tr>
</tbody>
</table>
### 8 Contactors

(i) Rating of contactors shall be at least 50% higher than the respective motor full load current at the specified duty cycle. The ratings of the contactors have to be specified in Amps. The contactor should be of reputed makes like Siemens/ L&T / Havells/ Telemechanic / BCH or equivalent.

(ii) Number of NO & NC contacts has to be specified for each contact. Spare quantity in case of each of contact may be considered.

### 9 Limit Switches

(i) Hoist, Long Travel and Cross Travel motion should be provided with the Limit Switches to prevent over hoisting, over lowering and over Traveling. For crass travel and long travel shall be of lever type with self-resetting feature and incorporated in the Control circuit of the drive motor. Hoisting should have 2 Nos. limit switches i.e. gravity type and rotary type for crane having SWL 2T & above. <= 1T Cranes having Rotary limit switches & Additional Roller type limit switches

(ii) Limit Switches for Travel motion shall be of self-resetting lever type incorporated in the control circuit of the drive motor.

### 10 Overload Protection

Each hoist should be equipped with overload protector, which shall prevent the lifting of load beyond the capacity of the each hoist on the crane.

### 11 Control Panel

(i) All power and auxiliary contactors, individual overload relays, time relays etc., should be mounted in CRCA 14swg sheet steel cubicles with lockable-hinged doors. The door hinges should be of such type during repair works inside the panel, the entire door can be lifted out and placed away enabling better access inside the panel. Interior of the panel should be dust and vermin proof. Cables shall be of reputed makes like Finolex / Polycab / Skytone / Gloster etc

(ii) Panels should be front wired with readily accessible terminal blocks for making connection to the external equipment. Panels should be pre-wired upto terminal strip. Multi core copper conductor should be used for control circuit wiring in the panel.

(iii) All contactors etc., should be mounted securely in a vertical arrangement with the due consideration to the vibration encountered in the operation of Crane. The bottom most of row of equipment mounted in the panel, except terminal strips should be atleast 200 mm above the panel bottom cover to facilitate inspection and repair.

(iv) All the equipment should be so mounted in the panel as to enable its easy removal / replacement from the front.
Terminal strips should be fixed inside with ferrule the panel preferably in horizontal manner, leaving enough space underneath the panel for termination of cables in a convenient manner. Power and Control terminal should be segregated. Power terminal block should be operated from each other by means of replaceable insulated spacers. Terminal block should have enough clearance to avoid tracking. A minimum of 20% spare terminal should be provided in terminal strips.

All equipments inside the panel should have permanent identification labels in accordance with circuit diagram as also the power and control terminal. Terminal blocks should be robust and of such construction as to preclude possibility of cable connections getting loose due to vibration of Crane.

Panels should be mounted such that bottom of panel is at least 150mm above the floor.

The electrical clearance in air between all live parts of different polarity and voltage and between live parts and earth should not be less than 75 mm.

The control panel for Hoist, Cross Travel and Long Travel, shall be provided on the short platform near to end carriage or over the End carriage.

Circuits of all the travel motions of the crane i.e. hoisting / CT / LT shall be protected with individual MCB’s. The rating of MCB’s shall be selected according to the load curves of the individual motors.

Power and control circuit diagrams to be attached inside the control panel doors in proper manner.

1 No. independent MCCB main switch with in sheet metal enclosure type should be provided for each Crane near to the Control panel. (MCCB Should up based O/C, S/C, S/F, E/F)

415 ± 10% V. 3 Phase, 50 ± 3% cycles AC.

Earthing of all electrical gadgets in the crane confirming to IS 3043 (Indian Electricity rules) shall be in the scope of crane supplier whereas excavation of pit, piping and other necessary works shall be in the scope of Electrical contractor. The crane structure, motor frames and metal cases of all the electrical equipment including metal conduits shall be effectively connected to earth through copper conductors, complying with Indian Electricity Rules.
### Control Voltage

1. **Control Voltage**
   - Control Voltage: 110 + 10% V. AC single phase.
   - The control voltage shall be obtained through individual separate transformer connected to 3 phase, 415 Volts AC supply.

2. **Control**
   - Control: i) All the three motions (Hoist, Cross travel & Long travel) should be with two speeds (normal and micro speed).
     - This system has to be provided in the control panel of reputed make.
     - The make of the control should be specified by crane supplier for the approval of the Client / Architect.
     - Speed variation has to be proposed as an option.
   - ii) One indication lamp has to be provided in the crane control box. It shall be ON when the crane is ON.

3. **Pendant station**
   - Pendant station: Control Pendent Push Button Station for controlling all the motions movable along the span for cable support suitable guide rings /wire rope track and associated hardware for ensuring smooth movement of pendant to be suspended by suitable multistrand wire rope. The switches shall be capable of withstanding rough handling without being damaged and the cover shall be effectively secured.

4. **Current Collection for Hoist**
   - Current Collection for Hoist: Festooned cable current collection system with PVC flexible cable shall be provided for Cross Travel motion as current collection system for Electric Hoist.

5. **Down shop Lead System**
   - Down shop Lead System: Down shop Lead system to feed power supply to the Crane will have 4 line shrouded galvanized of Insulated Conductor SAFE TRACK/ SAFE LINE shall be provided for the full length of the travel supported at intervals with brackets. 4 Nos. Pentagraph current collectors of fully articulated sliding type should be provided for each Crane to have spring loaded pressurized electrical contact with the shrouded bus bar. The galvanized bus bar rating shall be 100 Amps minimum. A switch fuse of required capacity will be provided by the electrical contractor at 1.5 M height from floor level at one end of the shop free of cost to crane supplier to tap the power supply for the Cranes.

6. **Paint**
   - Paint: All structural parts shall be thoroughly scrapped, cleaned, two coats of red oxide primer and two coats of synthetic enamel golden yellow (IS 5 2004 shade code 356) shall be applied before delivery. Touch up to be done after commissioning wherever it is necessary.

7. **Anti fall & anti derailing arrangement required.**
21 Test Certificate : The supplier shall submit test certificates for the following:. Copy of following test certificates of bought out components will be submitted:

   a. Test certificates for electric motors.
   b. Test Certificates for Brakes.
   c. Test certificates for Limit Switches.
   d. Test certificates for Wire Ropes.
   e. Chemical analysis of raw materials
   f. Mechanical properties.
   g. Hardness tests.
   h Radiographic inspection, if any.
   i Test certificate for hook.
   j. The supplier shall also submit test certificates for all the bought out items.

22 Quality Plan : Manufacturing Quality Plan for each type of crane should be submitted for approval before commencing the fabrication.

23 Inspection and Dispatch (Pre-Dispatch Inspection) : Inspection after complete assembly at floor level for dimensional check and idle test run to be carried out for each crane before dispatch from the manufacturer’s works / sub contractor’s premises. However, assembly and load test should be carried out for each electric hoist before dispatch from the manufacturer’s works. Purchaser’s representative should carry out the inspection of the above. Final acceptance shall be after successful erection, commissioning, load testing at HAL site and submitting the certificate for safe use of the crane.

24 Packing & unloading at site : The hoist shall be packed in waterproof packing. Unloading at site shall be in the supplier scope

25 Erection & Load Test : Erection, testing and commissioning of the Crane at site should be carried out as per IS: 3177. Test loads and slings for conducting the full load and 25% overload test will be Crane supplier scope at the site of erection.

Load testing of the crane, which shall be carried out as per current Factory rules by a competent person authorized by statutory authority shall be in the scope of crane supplier/vendor.

Safety during erection must be followed strictly.

26 Spare parts : Spares for 2 years normal operation after the warranty for all the cranes and hoists to be separately indicated with price schedule as optional. The list of spares has to be given by the supplier and validated by HAL maintenance department.

27 Guarantee : Guarantee against use of defective materials and bad workmanship for 12 months from the date of commissioning or 18 months from the date of delivery whichever is earlier. In case any defect is noticed under normal use during the guarantee period the supplier shall arrange replacement / rectification free of cost on return of defective parts to the purchaser on freight paid basis.
### 28 Annual maintenance contract

An AMC offer after warranty period shall be provided separately with a number and frequency of visits (1 visit in every 2 months).

### 29 Drawing

General arrangement drawing showing clearances and wiring diagram to be sent for approval within 4 weeks of receipt of the order. The drawing shall be approved by Consultant and or coordinated by the HAL. The scope of coordination will only cover the general arrangement of the crane. Hence even if some specific details are mentioned in the approved GA drawing, the liability of performance w.r.t. to these specific details in accordance with tender specifications lies with the vendor who has entered in the contract with HAL.

### 30 Manuals

Erection, operation and maintenance manual for the crane should include the following:

* Purchasers purchase order number & crane Sr. No.
* General arrgt. Drg. Electrical wiring diagram (Power and Control)
* General information regarding equipment commissioning & maintenance inspection
* Description of components with part lists.
* Sub assembly drawings.
* Recommendations for lubrications and lubricants.
* L.T. machinery sub-assembly (L.T. Mechanism).
* C.T. Mechanism.
* Hoist Mechanism.
* Hook block assembly.
* Trolley current collection system.
* Rope drum assly.
* Wheel assembly drawings (LT & CT).
* Anchoring arrangement.
* Sectional details of gearboxes.

One set of soft copy for all the approved drawings along with maintenance manual to be submitted.

### 31 Authority Approval

Vendor has to get the Approval from appropriate statutory authority for the crane related works.

Certificate from crane vendor / statutory authority for the safe use of the crane to be provided.

Warranty certificate to be provided.

### 32 IS Standards

**APPLICABLE STANDARDS AND CODES:**

8. IS: 3815:1969 : Point hooks with shanks for general engineering purpose
<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>MAKE</th>
<th>OTHER DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bearings</td>
<td>SKF / FAG / Timken / RHP or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>equivalent - reputed</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cables</td>
<td>ISI approved</td>
<td>Cables with copper conductors only, Flex CL5</td>
</tr>
<tr>
<td>3</td>
<td>Connectors</td>
<td>Elmex / Wago</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Cont actors</td>
<td>SIEMENS / ABB / Telemecanique</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Master Controller</td>
<td>Siemens / SOC / WMI / EMM</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Couplings</td>
<td>Hi-Cliff / WMI / OEM</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Fuse / Fuse holders</td>
<td>English Electric / SIEMENS</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Hooks</td>
<td>Herman Mohatta / Hercules /</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel Forgings / Smriti</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forgings / EE Karachiwala</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Isolator Switch</td>
<td>SIEMENS</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Isolators</td>
<td>SIEMENS</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Limit Switches</td>
<td>Siemens / SOC / OMEGA</td>
<td>IP54 or better</td>
</tr>
<tr>
<td>12</td>
<td>MCB</td>
<td>SIEMENS</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>MCCB</td>
<td>SIEMENS</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Motors</td>
<td>BBL / CROMPTON GREAVES /</td>
<td>IEC Frame sizes, IP54 or better</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ALSTOM / SIEMENS / ABB</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Overload relay</td>
<td>SIEMENS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Electrical)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Overload relay</td>
<td>ELECTROGEAR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Mechanical)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Panels</td>
<td>SIEMENS / GODAVARI ELECTRICALS / DANDAPANI / Original equipment manufacturer</td>
<td>Should be made from 18 G sheet steel, Powder coated and should be provided with panel locking facility.</td>
</tr>
<tr>
<td>18</td>
<td>Pendent pushbutton station</td>
<td>HANSU</td>
<td>With colour coded pushbuttons and name plates</td>
</tr>
<tr>
<td>19</td>
<td>Pneumatic timers</td>
<td>Bharatia Cutler Hammer</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Push Buttons</td>
<td>SIEMENS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rails</td>
<td>CR-80 / CR-100 / CR-120 / Square bar as per IS-3443</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------</td>
<td>-----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Rails</td>
<td>CR-80 / CR-100 / CR-120 / Square bar as per IS-3443</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Resistance Box</td>
<td>BCH / SOC / WMI / OMEGA</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Thruster Brakes</td>
<td>SOC / WMI / OMEGA / SNS</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Wire Rope</td>
<td>Usha Martin / Fort William / Bharat wire ropes / Desh wire products</td>
<td></td>
</tr>
</tbody>
</table>

The party has to comply all the makes as given above, incase of deviation only reputed makes as approved by consultant and/or HAL shall be acceptable.

Note:-
Refer drawings no's
(g) HAL-AAS-AR-1 01(19/1) HAL-MAA-AR-1 01(20/1) HAL-TSFA-AR-1 01(21/1) HAL-LGS-AR-1 01(22/1) HAL-CMR-AR-101 (25/1)
TECHNICAL SPECIFICATIONS FOR LIFTS

PART -V

1.0 SCOPE

This specification covers the requirements of design, manufacture, assembly, testing, delivery, installation & commissioning of Passenger and Goods lift with machine room requirement M/s. HINDUSTAN AERONAUTICS LIMITED, AIR CRAFT DIVISION, OJHAR, OJHAR TOWN SHIP PO ,NASIK, MAHARASTRA.

2.0 SITE CONDITIONS

- Temperature: Maximum 45 Deg. C, Minimum 10 Deg. C
- Humidity: Not more than 80% at maximum temperature.
- Rainfall: 1000 - 1500mm Per Annum

3.0 ELECTRICAL SUPPLY SPECIFICATIONS

3. System voltage
   Nominal voltage: 415 V

4. Voltage variation limits: +/- 10%

5. No. of phases: 3

6. Frequency: 50 c/s

7. Frequency variation limits: +3% or -5%

8. Fault level: Not exceeding 50 KA at 415 V

9. Neutral earthing on LV side: Solidly earthed

5.0 INSTALLATION

a). The LIFT shall be installed as per IS : 1860.
   Wiring and earthing shall be extended from the electrical shaft & lift shaft as per requirement.
   Power cable & earthing point will be made available at power panel at one location for each lift by other agencies.

b). All openings at the various landings shall be temporarily guarded during installation.

c). All safety procedures associated with lifting of heavy equipment, operation of electrical tools & earthing should be strictly complied with.

d). All electrical wiring shall have flame resisting moisture proof insulation and will be run in heavy gauge metal conduit/ casing.
The trailing cable between the car and lift well will be multicore type designed for lift services and will have flame resisting moisture proof covering.

Cables should conform to relevant IS amended up to date.

The supply and erection of lift shall conform to the latest lift act in force and modern lift practice in all respects.

All wiring and earthing etc. shall conform to IE rules and regulations.

(viii) TESTING

All equipment included in contractor’s scope of supply shall be tested at Manufacturer’s Works, before delivery and necessary Test Certificates shall be submitted for approval of Consultants.

6.1 The Contractor shall carry out all performance tests after installation, in the presence of the Client / Consultants, as per specification.

The Contractor shall bear all expenses for such tests.

6.2 The Contractor shall be responsible for executing the contract as per Indian Electricity Rules, Rules and Regulations of supply authorities and the Rules of the local Electrical Inspectorate.

Any changes/modifications pointed out by the authorities shall be carried out at no extra cost.

(x) OTHER TESTS

Each elevator shall be tested at site as per IS 4666 & EN 115. Among others, the tests shall include:

a) Operational tests with functional check on safety devices
b) Speed of operation at rated load
c) Over speed tests.
d) Leveling accuracy
e) HV test
f) Earth resistance.

7.0 TAKING OVER OF INSTALLATION

7.1 The equipment & installation shall be deemed to have been taken over by the Client, when the following are completed:

(x) The Consultants have certified that all contractual obligations have been fulfilled by the Contractor.

(xi) All performance tests shall be carried out in the presence of client / consultant and Test Certificates are furnished in requisite copies.

(xii) The installation is approved by the lift inspectorate.

(xiii) The ‘As Built’ Drawings are submitted. ( Hard and soft Copies )

8.0 COMPONENTS & ACCESSORIES

The following components & accessories forming a part of the elevator installation shall be supplied and installed.

All the items shall conform to the requirements of the BIS listed above and the specification.

(e) Guide rails of steel with working surfaces machined for the car and counter weight.
(f) Spring buffers located in the lift pit.

(g) Steel car frame with replaceable guide shoes.

(h) Lift cars fitted with all interiors, false ceiling, flooring, ventilation fan, lights, operator’s panel, floor indicator, Lift mirror, Handrails, emergency stop facility etc.

(i) Motor operated sliding, center opening car doors wherever applicable.

(j) Motor operated sliding, center opening landing doors wherever applicable.

(k) Counter weight with guide shoes.

(l) Safety gears.

(m) Speed governors.

(n) Suspension ropes

(o) Sheaves & pulleys

(p) Lift machines

(q) Controllers & wiring materials

(r) Terminal stopping and final limit switches.

(s) Leveling devices

(t) Lifting beam for machines.

(u) Any other accessories as required.

**Lift Announcement:**

The lift shall be provided with special announcements as follows:-

(a) When supply is out and lift is working in ARD (Automatic rescue device) announcement shall be “supply is out you may alight from the lift as soon as the door opens”

(b) When supply is out, ARD is not working, and the lift stops in between floors announcement shall be “ARD” is not working please ask help through intercom

**90 General Technical Specification**

**91 DETAILS OF LIFT WELL**

9.1.1. The lift well shall be as per clause 5 of IS: 14665.

9.1.2. There shall be no other opening in the lift well except for the landing openings.

All landing openings in lift well enclosures shall be protected by doors/ collapsible doors, which shall extend to the full height and width of the landing opening

9.1.3. Light points shall be provided in the lift well at a spacing not exceeding 10m.

All the light points shall have control from the machine room.
A socket outlet may also be provided at a suitable place for use by maintenance staff above the ground floor landing.

9.2 LIFT PIT:

The lift pit shall be provided proper water proofing treatment so that the same remains dry.

If the lift pit depth is more than 1.6m, a ladder to the height of 0.75m above the lift pit floor shall be provided to reach the lift pit.

The lift pit shall have provision for a separate access.

In case of two lifts in the well, one access to the lift pit shall be adequate.

d) MACHINE ROOM:

The load carrying capacity of the floor shall be obtained from the lift manufacturers.

Suitable lifting beams below the machine room shall be provided for lifting any heavy object as per requirement of the lift manufacturer.

Provision for pulley for lifting of heavy items / lift machinery is required which will facilitate inspection and repair.

The machine room shall be properly ventilated.

9.4 PARTITION IN LIFT WELL

Where two or more lifts are installed in a common lift well provision shall be made by dividing beam and rigid metal screen to separate each lift from an adjacent lift or its counter weight.

e) GUIDE RAILS

The guide rails shall be as per IS: 14665.

Rigid steel guides shall be used for guiding lift car and counterweight throughout its travel.

The strength of the guides, its attachments and the joints shall be sufficient to withstand the forces imposed due to the operation of the safety gear and deflection due to uneven loading of the lift car.

Only machined guide rails shall be provided for passengers and hospital lifts.

The guide tracks shall be supported at suitable intervals and shall be embedded into the walls.

Wood or fiber blocks or plugs shall not be used for securing guide brackets.

9.6 GUIDE SHOES

Two numbers of guide shoes at the top and two numbers at the bottom shall be provided on the lift car and counter weight.

Guide shoes shall be provided with adjustable mountings and shall be rigidly secured in accurate alignment at the top and bottom on each side of the car sling and counterweight frame construction.

When oil buffers attached to the bottom of the counterweight are used then additional guide shoes shall be provided on each side of the buffer frame.

For passenger lifts and bed-cum-passenger lifts, sliding guide shoes shall be provided for speeds up to 1.5 mps (meter per second.)
Solid guide shoes can be used for counter weights for speeds up to 1.0 mps.

When speed exceeds 1.5 mps, roller guide shoes shall be provided for car and the counterweight.

97 **BUFFERS:**

Buffers shall be provided at the bottom limit of travel for cars and counterweights.

Energy dissipation type buffers shall be used wherever the rated speed of the lift exceeds 1 mps but energy accumulation type buffers shall be preferred if the rated speed of the lift does not exceed 1 mps.

**(v)** **COUNTER WEIGHT:**

The counterweights shall be of metal and it shall be in the form of multiple sections.

It shall be contained and secured within a steel frame and shall be equal to the weight of the complete car plus approx 50% of the rated load.

At least, four guide shoes, capable of being easily renewed or having renewable linings shall be provided on the counterweight.

**(g)** **SUSPENSION ROPES**

Cars and counterweights shall be suspended from round strand steel wire ropes of best quality having a tensile strength not less than 12.5 tonnes/cm².

The size and number shall be in accordance with standard Code of practice/BIS specifications.

Lubrications between the strands shall be achieved by providing impregnated hemp core. The nominal diameter of the ropes shall be at least 8mm.

9.9.1. **COMPENSATION ROPES**

For travels over 40 m and/or rated speed of the lift exceeds 2.5 mps, the proven of compensation ropes with tensioning pulleys shall be considered.

For speeds of 2.5 mps or below, quiet operating chains or similar devices shall be used as the means of compensation.

For speeds above 3.5 mps, an anti-rebound arrangement of idler tension pulley shall be provided to prevent the counterweight jumping with the application of the car safety gear.

**(h)** **CAR CONSTRUCTION**

The lift car construction shall be in conformity with Code of Practices, BIS specifications and IE Rules.

1. **CAR FRAME**

The lift car body shall be carried in a steel car frame sufficiently rigid to withstand the operation of the safety-gear without permanent deformation of the car frame.

The deflection of the members carrying the platform shall not exceed 1/1 000 of their span under static conditions with the rated load evenly distributed over the platform.

2. **CAR ENCLOSURES:**

The whole of the internal face of the car shall be of 1.5 mm thick stainless steel sheet lined.

A suitable backing shall be used to reinforce the car wall panels.
A stainless steel handrail shall be provided on three sides of the lift car, extended to within 150 mm of all corners and a stainless steel skirting panel approximately 100 mm deep shall be provided.

Stainless steel false ceiling with concealed fluorescent light fitting and ventilating fan complete with metal ceiling diffuser shall be provided.

The car ventilation fan shall be switched off within a period which shall be adjustable from 5 to 15 minutes after the last registered call is answered.

The lift car excluding linings, shall be constructed of non-combustible materials.

The lift car shall have adequate illumination.

The illumination level shall not be less than 150 lux on the lift floor level.

**3 EMERGENCY LIGHTING:**

The lift car shall also be provided with emergency lighting operated by a rechargeable battery supply.

The lighting shall be automatically switched on in the event of failure of normal power supply to the lift.

**4 CAR PLATFORM:**

The lift car platform shall be designed on the basis of rated load evenly distributed.

The dimensions shall conform to IS: 14665 unless otherwise specified.

The flooring shall be smooth and non-skid type.

The PVC/rubber flooring of minimum 3mm thickness shall be preferred for passenger and bed-cum-passenger lifts.

The flooring for goods lift shall be strong enough to take the rated load without any deformation or damage.

**5 CAR ROOF:**

The car roof shall be solid type and capable of supporting a weight of at least two persons (approx 140 kg) without causing permanent deformation.

Ceiling lights shall be of recessed type and be protected by stainless steel metal bars.

A recessed ceiling fan complete with heavy duty metal diffuser and capable of providing 20 air changes per hour in the car shall be provided.

**6 CAR DOORS:**

The doors for passenger lifts shall be of metal and the internal face of the car door shall be suitably lined as the same in the lift car.

The doors shall be in two panels and centre opening with automatic power opening and closing unless otherwise specified.

The car shall be equipped with an electronic door sensor which can detect an obstruction at the car entrances and control the closing of the doors.

The car door shall be provided with an electrical switch which will prevent the lift car from being started or kept in motion unless all car doors are closed.

**7 DOOR RE-OPENING DEVICE:**

Door re-opening device shall be fitted to the leading edge of both car door panels, which shall automatically initiate re-opening of the door in the event of a passenger being struck (or about to be struck) by the door in crossing the entrance during the closing movement.

It shall be so designed and installed that for centre opening doors the obstruction of either leading edge when dosing will cause it to function.
"DOOR-OPEN" ALARM FOR MANUALLY OPERATED DOORS:
For manually operated doors and were assisted doors, a 'door open' alarm shall be provided in the
car to draw attention to a car or landing door which has been left open for an adjustable period up
to 10 minutes.

LANDING DOORS
The car entrance shall be provided with a car door, which shall extend to the full height and width of
the car opening.
The opening for the landing doors shall not be wider than that of the lift car.
The top track of the door shall not obstruct the car entrance.

All landing openings in lift well enclosures shall be protected by doors / collapsible doors which
shall extend to the full height and width of the landing opening.

1. VISION PANELS
The landing doors shall be provided with transparent vision panel of minimum thickness 6mm,
made of an approved material or glass of a tempered or laminated type.

2. LANDING DOOR LOCKING DEVICE
Every landing door shall be provided with an effective locking device so that it shall not normally be
possible to open the door from the landing side unless the lift car door is in that particular landing
zone.

It shall not be possible under normal operation to start the lift car or keep it in motion unless all
landing doors are in the closed position and locked.

TERMINAL STOPPING AND LIMIT SWITCHES
The lift shall be provided with normal terminal stopping switches and limit switches.

They shall be positively operated by the movement of the car.

These switches shall either be mounted on the car frame or in the lift well.

9.12.1 The limit switches shall either open directly by mechanical separation of the circuits feeding the
motor and brake, and provisions shall be made so that the motor cannot feed the brake solenoid,
or open, by an electrical safety device, the circuit directly supplying the coils of the two contactors,
the contacts of which are in series in the circuits supplying the motor and brake.

SAFETY GEAR
The lift (except service lift) shall be provided with safety gears capable of operating only in the
downward direction and capable of stopping a fully laden car, at the tripping speed of the over-
speed governor, even if the suspension devices break, by gripping the guides and holding the car
there.

OVER-SPEED GOVERNOR
The car safety shall be operated by speed governor located overhead and driven by governor rope
suitably connected to the car and mounted on its own pulley.

Over-speed governor shall operate the safety gear at a speed at least equal to 115% of the rated
speed.

For rated speeds up to 1 mps maximum governor tripping speed shall be either 140% of the rated
speed or 0.88 mps, whichever is higher.
For rated speed exceeding 1 mps, maximum governor speed shall be 115% of the rated speed plus 0.25 mps.

The means for adjusting the over-speed governor shall be sealed after setting the tripping speed.

1. GOVERNOR ROPES

The governor ropes shall not be less than 6 mm in diameter and shall be of flexible wire rope.

The rope shall be tensioned by a tensioning pulley and the pulley (or its tension in weight) shall be guided.

The breakage or slackening of the governor rope shall cause the motor to stop by means of an electrical safety device.

The device shall be of bi-stable type requiring manual reset.

(m) OVERLOAD DEVICE AND FULL LOAD DEVICE

The lift shall be provided with an overload device which shall operate when the load in the car is 10% or more in excess of the rated load of the lift.

The overload device, when in operation, shall:

(i) prevent any movement of the car,

(ii) prevent the closing of any power operated door whether fitted to the car or To the landing at which the car is resting, and

(iii) give audible and visible signals inside the car.

The lift shall resume normal operation automatically on removal of the excessive load. The overload device shall be inoperative while the Lift car is in motion.

9.15.1. FULL LOAD DEVICE

The lift (other than a service lift) shall be provided with a full load device having an adjustable setting range from 80% to 100% of the rated load and when operated, it shall by-pass all landing calls.

When the load in the car is reduced, the car shall stop for landing calls as normal.

9.16 EMERGENCY ALARM DEVICE

An emergency alarm push button together with a buzzer (or an alarm bell) shall be provided in the lift car and connected to the machine room and the main entrance lift lobby and backed up by an emergency supply. The pattern of lift alarms shall be distinguishable from that of fire alarms.

9.16.1 An intercom system connecting the lift car and the machine room /guard room (if manned) shall be provided.

9.17 EMERGENCY EXIT

The lift car shall be provided with an emergency exit in the roof of minimum size 500 mm x 350 mm x 400 mm in diameter.

Panels for emergency exits shall:

- be clear of any apparatus mounted above the roof of the lift car
- be capable of being opened, re-closed and re-locked without a key
- be provided with an electric safety device which will prevent operation of the lift

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
CONTROL AND INDICATION IN CAR

The lift car shall have a control faceplate made of stainless steel with thickness of not less than 25mm and comprising :-

(i) Call buttons with acceptance signals to correspond with the landing served
(ii) An alarm push button with protection from being operated accidentally
(iii) "Door open" and "Door close" push buttons
(iv) Audible and visible signals in connection with the overload device
(v) light switch, alarm reset switch, fan switch and cleaner's "Stop-switch" keeping the car door open in the form of key switches or housed in a recessed metal box with hinged or sliding lid which will be key-locked,
(vi) Two-way intercom speaker (optional),
(vii) The control faceplate shall be fixed onto the car panel by stainless steel screws.

9.18.1 For lifts equipped with attendant control, the control faceplate shall also incorporate a non-stop button for the purpose of bypassing landing calls, but the calls shall remain registered until answered. This button shall be inoperative unless the lift is operated by an attendant.

9.18.2 The car direction and position indicator shall be of digital type display with LED’s actuated by solid state circuitry unless otherwise specified. The position indicator shall have a minimum height of 50 mm and easy to read even from distance and properly illuminated.

9.19 LIFT MACHINERY FOR ELECTRIC LIFT

9.19.1 LIFT MOTOR

The induction motor shall be designed to operate for an unlimited period according to the expected duty of the lift.

The motor may be supplied and controlled by static elements when A.C. variable speed system is specified.

9.19.2 MOTOR GENERATOR SET (Not Applicable)

The motor generator set shall comprise a motor and a generator built as a complete unit directly coupled.

The motor and the generator shall be suitably rated to deal with the load and speed specified.

Controls shall be provided so that the set shall start up on the registration of a landing call or car call and shall continue to run for a period which shall be adjustable from 5 to 15 minutes, after the last registered call is answered.

9.19.3 BEARING AND GEAR CASE

Bearings shall be of the ball bearing type or sleeve ring type with oil ring bearings

Gear cases shall be provided with thrust bearings suitable for the application.

9.19.4 EMERGENCY OPERATION BY MANUAL DEVICE

For geared lift machines, the hoisting machine shall be provided with a smooth wheel which may be fitted to the shaft to move the lift car up or down by manual operation.

The direction of movement of the car shall be clearly indicated on the machine.
9.19.5 EMERGENCY OPERATION BY ELECTRICAL SWITCH

For machines where the manual effort to raise the car together with its rated load exceeds 400N, an electrical switch for emergency operation shall be installed in the machine room.

Directional push buttons protected against accidental operation shall be provided in the machine room such that when the emergency electrical switch is operated,

The car can be moved up or down by applying constant pressure on the buttons.

The car speed under the emergency operation shall not exceed 0.63 m/s.

The emergency electrical switch and its push buttons shall be so placed that the machine can readily be observed during operation.

9.19.6 ELECTRO-MECHANICAL BRAKE

Every lift machine shall be provided with a brake which is capable of stopping the machine when the car is traveling at its rated speed and with the rated load plus 25%.

It shall also be fitted with a manual emergency operating device capable of having the brake released by hand while a constant manual pressure is required to keep the brake open.

9.21 GOODS LIFT

9.21.1 DETAILS OF THE GOODS LIFT CAR

The side and rear wall panels shall each be provided with three-equally-spaced full length lateral protective wooden battens of 200 mm wide by 25 mm thick.

The surface of the wooden battens shall be covered with 1.0 mm thick metallic sheet as required.

The top battens shall be fixed at a height of 1100 mm above finished car floor level.

The car roof shall be able to support the weight of two persons without causing permanent deformation.

Ceiling lights shall be of recessed type and be protected by stainless steel metal bars.

A recessed ceiling fan complete with heavy duty metal diffuser and capable of providing 20 air changes per hour in the car shall be provided.

The car floor shall be constructed of metallic sheet of suitable thickness with 2 mm high multi-grip non-slip pattern.

The floor construction shall be in the form of a metal drain pan (optional).

In case of metallic floor being drain type, the rear and side edges shall be folded up by 100 mm from the floor to form the drain pan.

All joints and the corners of the pan shall be welded to prevent water leakage.

The goods lift cars may also be constructed as mentioned above except the floor drain system.

9.21.2 GOODS LIFT CAR DOOR

The car doors shall be robust, manually operated, horizontally sliding and made of stainless steel / MS sheet. Power operated, automatic, horizontally sliding doors shall be multi-panel of stainless steel construction, similar to those for passenger lifts, but strong enough for goods lift use.

SERVICE LIFT

Neither the internal depth nor the internal width of the car shall exceed 1.00 m. The overall internal height of the car shall not exceed 1.20 m. The rated load shall not exceed 250 kg.

9.22.1 LIFT CAR AND METHOD OF DRIVE:

Service lift cars shall be of rigid construction and totally enclosed except for service openings and made of wood or metal and reinforced at the point of suspension.
The car shall not be made of inflammable materials.

Two pairs of renewable guide shoes shall be fitted.

Unless otherwise specified, removable shelves shall be fitted inside the car and be so retained that they shall not be displaced by the movement of the car.

The car shall be constructed with openings on opposite sides and shall be provided with some form of protection to prevent the goods from projecting outside the car.

The method of drive for the lift shall be by traction i.e. sheaves and ropes or by positive drive using drum and ropes without counterweights.

9.22.2 GUIDE:

The car and counterweight shall each be guided by rigid guides.

Guides and their fixings shall be capable to withstand the application of the safety-gear (if provided) when stopping a fully loaded car or counterweight.

9.22.3 BUFFER:

Buffers shall be provided under all cars and counterweights.

A lift with positive drive shall be provided with additional buffers on the car top to function at the upper limit of travel.

The buffers used shall be one of the following types viz spring, rubber or resilient plastic.

9.22.4 COUNTERWEIGHT:

Counterweights shall be of metal.

A metal frame shall be provided to prevent their displacement.

In the case of drum drive, there shall be no counterweight.

9.22.5 SUSPENSION

Cars and counterweights shall be suspended by means of round strand steel wire ropes.

The factor of safety of suspension ropes shall not be less than 10,

The minimum number of ropes shall be two and they shall be independent.

The diameter of sheaves or pulleys shall not be less than 30 times the rope diameter.

9.22.6 SAFETY GEAR

Safety gear tripped by an over-speed governor shall be provided for the car where the rated capacity is 250 kg, accessible spaces exist beneath the lift well or gross car roof area equals to or greater than 0.37 m2.

Where there is an accessible space beneath the well, the counterweight shall be equipped with safety gear.

9.22.7 LOAD PLATE AND WARNING NOTICE

A load plate giving the contract load of the lift in kg shall be fixed in a prominent position at each landing entrance.

A warning notice in English, Hindi and local language shall be prominently fixed at each landing entrance.

9.22.8 CAR AND LANDING DOOR

All landing openings in the lift well shall be protected by doors.
Every car or landing door shall be provided with an electric safety device which shall prevent the lift from being operated when any car or landing door is open.

It shall not be possible during normal operation to open a landing door unless the car is in the unlocking zone.

The landing doors shall be provided with the facility of being unlocked from outside with the aid of a special purpose key provided for use only by a competent lift worker.

**TERMINAL STOPPING SWITCHES**

Service lifts shall be provided with terminal stopping switches to stop the car automatically at or near the terminal service levels.

**(iii) PAINTING**

All exposed metal parts especially iron parts shall be painted with 2 coats of approved synthetic enamel paint after 2 coats of synchromesh primer after erection and before commissioning the lift.

**11.0 APPROVAL**

The supplier shall obtain the approval of drawings & installation from the CEIG.

Also approval shall be obtained from fire authorities for the features provided.

**12.0 DOCUMENTATION**

The suppliers shall furnish the following documentation in requisite number of copies (one each group of buildings)

(f) GA drawing of shaft & lift well giving all details to the civil contractors

(g) Lifting hook size and locations.

(h) Rail supporting and wall inserts

(i) Bracket location, shaft ventilation opening size and location.

(j) Control schematic GA of controllers

(k) Operation and maintenance manual

(l) Test certificates.

(m) As Built drawings.

**13.0 EXCLUSIONS**

The following are excluded from the scope of lift suppliers work

(2) Builders works associated with lift well, pit, and wall inserts.

(aa) Lifting beams.

(bb) Electrical wiring upto the Lift panel with isolator for incoming supply, earthing and lighting in lift shaft.

**14.0 SCHEDULE OF QUANTITIES**

The prices shall be quoted as per Annexure – I enclosed
15.0 GUARANTEE

15.1 The equipment supplied and the installation shall be guaranteed for satisfactory performance and workmanship, for a period of 12 months from the date of handing over the entire installation to the client in good working condition and liability of supplier under this guarantee include factored items repair or replacement of all defective parts if any, which may prove faulty during this period including such parts as may be tendered inoperative by wear-and tear but exclude such parts as may be rendered inoperative by vandalism.

The contractor shall replace free of cost all equipment or parts supplied by him and found defective within this period.

In case the contractor fails to replace or render services for defective materials & parts, the client reserves the right to do so, at the contractor's risk and expenses without prejudice.

16. FREE SERVICE

Periodical Service for the first 12 months will be carried out after the Lift has been handed over or offered for inspection.

The date of commencement of free service will remain unchanged irrespective of any delay in building completion, availability of permanent power supply, inspection, taking over or commencing the use of lift.

The Comprehensive AMC charges applicable for 3 years after warranty period shall be indicated separately.

17. SCHEDULE OF TECHNICAL PARTICULARS

The technical particulars called for in Annexure-II should be filled and furnished in the same format.

RECOMMENDED MAKE; OTIS, JOHNSON, KONE

TECHNICAL SPECIFICATIONS
FOR

FIRE FIGHTING WORKS
(PART VI)

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCOPE OF WORK</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>TECHNICAL SPECIFICATIONS FOR FIRE HYDRANT SYSTEM</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>TECHNICAL SPECIFICATIONS FOR ADDRESSABLE FIRE DETECTION &amp; ALARM SYSTEM</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>TECHNICAL SPECIFICATIONS FOR FIRST AID FIRE EXTINGUISHERS</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>31</td>
</tr>
</tbody>
</table>
TECHNICAL SPECIFICATION FOR FIRE PROTECTION & SYSTEM

(cc) SCOPE OF WORK
Following are the different items of work which have to be supplied, erected, tested and commissioned. The system to conform requirements as per local statutory bodies.

(n) Fire Hydrant System consisting of G.I. Piping with fittings, Valves, Yard Hydrants, and Hose Reels, Anti corrosion treatment, Painting & Accessories.

(o) Addressable fire detection & alarm consisting of Multisensor detectors, Heat detectors, Fire alarm control panel, Manual call points, Beam Detectors Cabling & accessories.

(p) First Aid Fire Extinguishers System consisting of ABC, CO2, Mechanical Foam Extinguisher & Accessories.

REGULATIONS AND STANDARDS
The installation shall conform in all respects to the following broad list of standards in general and in particular the materials used shall bear prevailing ISI marking:

a) IS:901-1975 : Specification for coupling, double male and double female, instantaneous pattern for fire fighting.


c) IS: 903 : Branch pipe, universal for fire fighting purposes.


g) IS: 884-1969 : First Aid hose reel for fire fighting.

h) IS:1332-1968 : Hose reel tubing for fire protection system.

j) IS: 2189 : Automatic Fire detection & Alarm


l) IS: 1239 Part -I : Mild steel tubes.

m) IS: 1239 Part -II : Pipe fittings.

n) IS:13039 : Butterfly Valves.

o) IS:5312 : Swing Check NRV

p) IS:13095 : Wafer Check NRV

q) IS:14846 : CI Gate valve Rising/Non Spindle

r) IS: 778 : Gun metal Ball/Gate valve

s) IS:10221 : Code of practice for wrapping & coating of under ground ms pipes.

t) IS 5714 : Specification for hydrant stand pipe for fire fighting.
responsibility

drawings

The drawings for the general guidance to the tenderer. The Contractor shall upon the award of the work, furnish detailed drawing necessary to carryout the work at site within 15 days. These shall be submitted for approval to the Architect/Consultants. The work shall be commenced only after the approval of drawing by the Architects/Consultants/Owners.

drawing/information required from successful tenderer within 15 days after award of work

a) Bar chart showing engineering, manufacturing and dispatch of each equipment and erection services.

b) Drawing, literature and technical particulars of all bought out items.

10. Schedule for valves and piping material.

11. Cross sectional drawings.

inspection and approval:

The contractor shall arrange all necessary inspection by the Local authority. He shall also arrange for the entire test, obtain and deliver to the Owner any approval required as per the local by-laws. It is the sole responsibility of the contractor to prepare & submit the drawings.

painting

All piping, furnished under this specification shall be properly painted with Two coat of red oxide primer and two coats of synthetic enamel paint fire red colour after installation and shall meet the requirements as outlined in Fire Protection Manual. Paint used for this work will be lead free quality.

Guarantee

The contractor shall give one year guarantee of the material and workmanship of the entire system is of first class quality and shall correspond to standard Engineering Practice. All the equipments/apparatus shall be guaranteed to yield the specified rating and design capacities, speeds. Any defective equipment/material/workmanship found short of the specified quality shall be rejected contractor shall make good the rejected items at his own cost. Guarantee certificate of equipment from suppliers/manufacturers shall be handed over to the Owner.

defects & liability:

All the equipment/material and the system shall be guaranteed against defective material and workmanship for a period of 12 months from the date of commissioning and handling over the Owners along with all relevant documentation. The contractor shall repair/rectify or replace all the defective materials, components free of cost. In addition, normal maintenance shall be carried out periodically during the defect liability period including replacement of spares, as required.

instruction manual/completion drawings/training

The contractor shall furnish detailed instruction and operation manual in quadruplicate. The contractor shall also furnish detailed completion drawings as soft copy and hard copy on tracing sheet drawn to an approved scale. The drawings shall be inclusive of control schematic, if any. The contractor shall train the Employer's personnel in the operation and maintenance of the system for one month.

testing

The contractor shall arrange to test the entire system as per the procedure enumerated under particular specifications, after the erection is completed. The tests shall be carried out to the satisfaction of Project Managers/Owners. The results of the tests shall be submitted to the Project Managers/Owner in triplicate. If the results of the tests are not found to be satisfactory by the Project Managers/Engineer-in-charge, necessary rectifications shall be done until the test results are found to be satisfactory. The installation shall be deemed to be completed only after the successful completion of the tests.
TECHNICAL DATA
The tenderers shall furnish data of their equipments as per the proforma under 'Technical Data'. The tenders without technical data is liable to be rejected.

CUTTING & WELDING PROCEDURE

CUTTING:
Pipe shall be cut mechanically (by saw or shear) or by oxy acetylene flame. No Electric metal arc cutting shall be allowed.
All edges cut by oxy acetylene shall be cleaned of impurities prior to welding joints.

CUTTING TOLERANCE SHALL BE AS FOLLOWS:
a) For pipe connected at both ends to 1mm
b) Elsewhere to 3mm

The edge preparation for welding of members more than 1/2" thick shall be done by flame cutting & grinding. Cut faces shall not have cracks or irregularities below 1/2" thick shall be done by Grinding Machine.

PREPARATION OF MEMBERS FOR WELDING:
Sharp edges, rust of cut edges, notches, irregularities fissures due to faulty cutting shall be chipped, grounded over the length, edge of the affected area.

Edge preparation for welding joints shall be carefully & accurately made so as to facilitate a good joint.

Generally no special edge preparation shall be required for members under 1/2" thick.

Edge preparation beveling denotes cutting & grinding of the same so as to result in 'V' or 'X' shapes as per IS:823.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy rust or dirt covered parts be assembled joints shall be kept free from any foreign matter, likely to get into the gaps between members to be welded.

WELDING PROCEDURE:
Welding shall be carried out only by fully qualified welders as tested & approved by the architects. Any test carried out either by the architects or their representative or the inspectors shall constitute a right by them for such tests & the cost involved there on shall be borne by the contractor himself.

When welding is carried out on open air, steps shall be taken to protect the place of welding against wind or rain, the welding electrodes and parts being welded shall be dry.

Before beginning the welding operation, each jointing shall be checked to ensure the parts to be welded or clean and root gaps provided as IS:823.

For single butt welds (in V) and double butt welds (in double V or U etc.). The re-welding of the root is mandatory but only the metal deposits of the root has been cleaned by back gauging or chipping.

The welding joints shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other methods.

For multilayer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping & wire brushing. Packing strips shall not be allowed i.e. All slag shall be removed.

WELDING INSPECTION:
The welding joints shall satisfy not to have any defects such as cracks, Incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes & porosity etc. beyond permissible limits.
TECHNICAL SPECIFICATIONS FOR FIRE HYDANT SYSTEM

PIPING:
Underground piping shall be of ERW G.I. ‘C’ class. The piping shall be laid not less than one meter below the ground level, suitable masonry supports, and concrete anchor blocks of suitable design shall be provided at every change in direction of pipeline both horizontal and vertical and near every pipe joints where soil conditions are unsatisfactory.

Above ground piping shall be ERW G.I. “C” Class unless otherwise specified and shall confirm to IS: 1239/3589 Part-I. G.I. pipes shall be provided with welded joints only unless flanges are warranted. All fittings shall be heavy grade wrought or G.I. conforming to ASTM A234 Gr. WPB (IS: 1239 Part II). The flanges shall be drilled as per relevant Indian Standards.

Flanges shall be faced and shall have insertion of neoprene rubber insertion of Gasket. The joints shall be capable of withstanding a pressure of 10.5 Kg/cm² all the above ground piping shall be supported by angle iron brackets on walls or suspended by hangers from ceiling or concrete pedestals at some places. Piping over ground shall be painted with two coats of approved enamel over a coat of zinc chromate primer after the installation and testing.

ANTI CORROSIVE TREATMENT FOR UNDERGROUND PIPING:
G.I. pipe laid outdoor buried in earth shall be wrapped with “Pypkote” make 4mm thick membrane consisting of seven layers of polyethylene polymerized bitumen and polyester mat laid over a suitable primer of fiber and solvent based rubber modified bituminous primer of density 0.9 gms/cum³ applied at the rate of approx 200 -250 gam/sq.m. Material to be laid strictly as per IS:10221.

Pipes passing through masonry walls, foundation, beams shall be taken through embedded pipe sleeve of same material. The pipe sleeve size to be at least 1 1/2 times the diameter of the crossing pipeline. The pipeline running below floor shall be given anti corrosive treatment same as for underground piping.

HYDRANT VALVES:
Hydrants should be located at a distance of not less than 2 m from the face of the buildings. This distance may suitably be increased up to maximum 15 m.

Cut off (Isolating) valves are necessary to obtain the best possible pressure. Cut off valve shall conform to IS codes PN 1.0, In case of system having working pressure in excess of 7kg/cm² PN 1.6 rating would necessary for valves.

Water shall be available immediately to all hydrants at all times, with all cut off valves being kept open. Before final inspection, the hydrant system shall be flushed thoroughly.

Connections for any purpose other than fire fighting are not permitted from the hydrants or from any portion of the hydrant service.

Except where impracticable, all hydrant outlets shall be situated 1.0 mtr above ground level.

The stand posts shall be 80mm in diameter for single headed hydrants. It is recommended that stand posts be painted ‘fire red’ (shade No.536 as per IS: 5) and numbered for easy identification.

At least one hydrant post shall be provided for every 30m in case of High Hazard occupancy.

Single headed Landing valves shall be of Gun Metal construction and of 63mm dia oblique female instantaneous pattern with S. S.caps and chains. Landing valves shall conform to IS: 5290 in all respects. Landing valves shall be of gun metal and fitted with 63 mm instantaneous female coupling conforming to IS: 901. The coupling shall be fitted with an internal blank cap (SS) secured by a chain. Landing valves shall be installed on hydrant risers at a height of 1.0 Mtrs from the floor level. The landing valves shall be connected to the wet riser stand pipes by means of a suitable tee, the cost of which is deemed to be included in the unit rate for piping. Flow rate of 1892/946 LPM for Single Headed @ 7 bar

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
HOSE REEL DRUM:

A 19mm dia braided rubber hose (Dunlop or approved make) of 36.0m length is placed near each landing valves. The hose reel is inbuilt with the chrome plated jet type nozzle. A 25 mm dia inlet pipe with threaded end is tapped from wet riser controlled by GM gate valve. The water flow rate shall be not less than 28 l/min and the Range of the jet shall be not less than 6 m. Working / Test pressure of 12 / 18 Kg/ Sq. Cm. The hose reel bracket shall be of swing type with swinging of 180° circular hose drum(made of CI or MS).

GATE VALVES:

Gun Metal Gate Valves Threaded type confirming to IS 778 to be placed for each Hose Reel cabinet to control the flow in Hose Reel. The valve shall be capable of withstanding 7 kg/sqcm working pressure of 16 kg/sqcm test pressure.

BUTTERFLY VALVES:

GI Butterfly valve(PN 16) Slim seal standard lever operated type conforming to IS standard with required flanges, nuts, bolts etc.

AUTOMATIC AIR RELEASE VALVE:

Gunmetal Screwed inlet Single acting type Automatic air release valve to be placed at all wet risers, so that the air bubbles formed as a result of leakages can be overcome. The valve shall be useful at the time of commissioning and maintenance. Working Pressure and Temperature is 10.5kg/Sq.Cm (g) and Ambient Temperature.

TESTING:

1. HYDROSTATIC METHOD:

After laying and jointing, the piping shall be pressure tested by hydrostatic method. The piping shall be slowly filled with water in order to expel all the air. The piping shall then be allowed to stand full of water for 24 hours. Any leakage at flanges or elsewhere shall be rectified. The pressure shall then be applied by means of a test pump (either hand or electric motor operated). The test pressure shall not be less than 1.5 times the working pressure for a period 2 hours. However, the test pressure shall not exceed 10.5 Kgs/cm² in any case.

2. RADIOGRAPHIC INSPECTION:

At least 10% of all the welded joints shall be radio graphically tested and half of the joints radiographed shall be field joints.
This entire test to be performed in the presence of Engineer in charge. The joint record shall be maintained by contractor.

3. HOLIDAY TESTING:

Before lowering the pipes in the trenches and before back filling the trenches the holiday test is to be done at min 20 KVA. Defective area shall be cleaned and re wrapped as per standard procedure for wrapping and coating.

Capacity of pumps (Diesel Pump, 273 M³/ Hr) shall be checked with respect to the contractor's piping and equipment layout. Tests shall be conducted to determine the delivery head, flow end BHP of pumps after installation. All the test results shall correspond to the performance curves. All the leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Owner/Architect /Consultant.

The system shall also be tested for its desired performance and function by opening hydrant valves on each floor separately and four landing valves simultaneously. The flow of water at the top most hydrants shall be checked when three landing valves below are open. The cutting in and cutting out pressure setting of starting device shall also be checked for its correct operation.

The test results shall be recorded and countersigned by Owner's representatives and submitted in triplicate for approval by the Owner.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
Commissioning:
After testing the system at a test pressure of 10.5 Kg/sq cm the system shall be commissioned for operation for the purpose of fire fighting. Same procedure is to be illustrated to be safety officer of client...

Excavation:
Excavation up to 1.0 mtrs. in depth, for laying pipes up to 150mm dia. Including forming bottom surface to required level, refilling the trenches with selected excavated earth around the pipe in layers of 150mm thick, watering, consolidating inclusive of disposing off / Carting away the surplus earth out side the site to a dump yard acceptable local bodies.

During excavation the contractor shall take particular care to avoid damage to existing drains, water mains, cables or other underground works. Where required, existing pipes, cables etc. Shall be properly slung or other wise supported.

Upto 300mm Normal soil, below 300mm hard rock.

Hard Rock
Any Hard rock (excluding laterite and hard conglomerate) or boulder for excavation for which blasting is required. This will also include plain cement concrete for the excavation for which blasting is required; reinforced cement concrete below ground level. Hard rock requiring blasting as described above but where blasting is prohibited for any reason and excavation has to be carried out by chiseling or any another agreed method.

Blasting of rocks
The contractor shall obtain license from the district authorities, where applicable, for under taking blasting work and for obtaining and storing the explosive rules 1049, revised up to date. The contractor shall purchase explosives, fuses, detonators only from the licensed dealers. He will be responsible for their safe custody and shall maintain an appropriate account of the explosive materials.

Precautions against blasting
Blasting operations shall be carried out under careful supervision of responsible authorized person preferable during certain specified hours. Only trained persons shall be employed. The blasting time shall be notified in advance to the surrounding areas. All precaution shall be taken to avoid accidents and to ensure safety of workers, public and property during blasting operations. Red flags shall be prominently displayed around the area to be blasted and all the people on work except those actually light the fuses, shall withdraw to a safe distance of not less than 200m from the blast.

Filling
Earth used for filling shall be free from salts, organic or other deleterious matter. All clods of earth exceeding 50mm shall be broken or removed. Unless otherwise indicated, where the excavated material is mostly rock, the rock fragment shall be broken into pieces not bigger than 150mm size and mixed with fine material consisting of decomposed rock, moorum or earth as available, so as to fill up with the voids as far as possible and then the mixture used for filling.

Dismantling
Dismantling of 150mm dia G.I fire hydrant pipe wherever existing pipes are not required as per site conditions. Filling of earth wherever dismantle as per site conditions and any all other existing works also contractor scope.

TECHNICAL SPECIFICATION FOR AUTOMATIC ADDRESSABLE FIRE DETECTION SYSTEM WITH AUTO DIALER FACILITY AT VARIOUS SHOPS / HANGERS PROJECT (PACKAGE II)

1 SCOPE OF WORK
Supply, testing, installation and commissioning of complete automatic addressable fire detection/alarm system with built-in TCP/IP networking feature (LAN compatible) and also having auto dialer facility to be installed at various shops/ hangars in the SU-30 ROH Project (Package I) on turn key
2 GENERAL REQUIREMENTS:

g) The design, supply and installation and testing of the entire fire alarm system shall confirm to EN54 / NFPA 72 / IS 2189 standards. The detectors shall confirm to relevant codes for fire alarm system such as IS 11360, IS 12456.

h) The detail dimensions of shops for installation for the said system is as per the tender drawings

i) The existing SU-30 Flight Hangar (099 Shop) shall also be included for installation of the automatic addressable fire detection system along with the other proposed locations.

j) The addressable fire detection system shall be LAN complaint (fire panels shall have built-in TCP/IP networking feature) with auto dialer facility shall be installed and commissioned totally on Turnkey Basis.

k) The vendor shall undertake detail site survey before quoting the systems to assess for any operational difficulties in integrating the new system with the existing system viz. any operational hindrances i.e., obstruction of buildings, pipelines, geographical conditions etc including actual requirements for the proposed system.

l) The layout drawing of system shall be submitted for prior approval.

m) Cost of any civil, electrical work involved in the commissioning / installation of the system shall be included in the quotation. Separate billing or any additional invoicing for the same shall not be considered.

n) The detection system shall be equipped with necessary feature for avoiding false alarm/call.

o) Initial expenditure for testing the system shall be born by the party.

p) The vendor shall submit 4 sets of manuals consisting layout & wiring diagram of Fire Alarm systems, List of spare parts with part numbers, SOPs, Preventive maintenance, Periodic Servicing, Sources of Suppliers for spare parts, etc.

q) Vendors shall attach list of the parties already carried out the installation/commissioning of similar nature & standard of work. The Vendor shall also submit the performance report of the same.

r) The offered system shall be brand new with state of the art technology and a proven field track record. No prototype equipment shall be offered

s) The Vendor shall ensure availability of spare parts and maintenance support services for the offered system for at least 10 years from the date of supply.

t) Party shall quote for tentative Annual Maintenance Contract (AMC) for three year after warranty / guarantee period separately in technical bid for information. The cost for AMC shall not be quoted in the price bid for proposed fire alarm systems. A guarantee certificate for taking up of AMC shall be submitted along with the quotation from the vendor duly signed

u) Party shall serve the warranty/ guarantee period for at least 05 (Five) years from the date of installation and commissioning and testing. Preventive maintenance/Servicing, defect rectification, free replacement of defective parts including attending emergency calls shall be cover under warranette period.

v) Test certificate, manuals and other relevant documents to be submitted.

w) The supplier shall conduct training for Standard Operation Procedure of the proposed system on free cost.

x) The detailed technical specifications of proposed fire alarm system consisting Addressable Control Panel, smoke detectors, beam detectors, manual call points, flashing- lights (beacon), hooter, etc
y) Party shall submit the point wise compliance report for all the requirements specified and deviations if any.

z) The new Addressable FDA system / Alarm Management Graphic Software shall have feature to get ‘status inputs’ of other existing addressable / conventional systems installed at the premises.

aa) The safety aspects during installation and commissioning of the proposed system shall be taken care by the vendor. The vendor shall provide necessary safety gear. Any accident happened during the installation & commissioning is sole responsibility of vendor. HAL will not be responsible for any mishapening or casualties during installation.

bb) All equipments/accessories required for installation and commissioning of the proposed system shall be brought by the vendor.

c) The bill of quantity is as per the tender drawing.

d) FIRE ALARM SYSTEM:

3. FIRe aLARM sYSteM:

3.1 The system shall be designed to detect smoke and generate audio and visual alarm in case of fire.

3.2 The fire alarm system shall confirm to BS-5839 / NFPA 72 in respect of designing and installation, and it shall give audio alarm signals when smoke density in case of photo detector exceeds the preset limit.

3.3 The system shall give pinpoint location of fire with warning system and voice communication for commands and instruction if required.

3.4 The system shall be a microprocessor-based control with central monitoring facility. The basic function of the system shall be able to achieve pinpoint location of alarm indication.

3.5 Secondary functions such as pre warning of possible alarm situation, self diagnosis, checking upon faulty detectors shall also be possible in this system.

3.6 It shall be possible to program each loop with minimum of 198 devices per loop. The FACP (Fire Alarm Control Panel) itself shall have the mother boards/interface of each loop built-in.

3.7 Annunciation (hooter alarm) facility shall also be inbuilt in to FACP, the panel being able to initiate alarm signal for any particular zone.

3.8 In case of actuation of devices due to smoke / fire condition system shall be such that HVAC system will be switched off thus avoiding circulation of smoke from affected areas to other areas.

3.9 The system shall be fully supervised for all fault conditions with distinctive alarm operated fault for fault and fire conditions.

3.10 Test push buttons software features shall be provided to test the electronic circuit and detectors conditions.

3.11 The FACP shall be so programmed that when a particular detector or group of detectors gives a fire signal the FACP shall be able to trip an individual AHU automatically.

3.12 In case of fire in the area conditioned by an AHU the FACP shall be able to trigger a relay that shall shut off the AHU through an additional contact provided in the AHU panel by the AC contractor.

3.13 The FACP shall have the provision for adding an extra loop card for a possible card burn out/malfunctioning. The loop card shall be incorporated in the FACP itself.
The system shall consist of fully addressable type fire alarm control panel, smoke detectors, linear beam detectors, manual call points, hooter, flashing lights (beacon), etc.

Each loop shall not be divided into more than 8 fire zones. Minimum two isolators shall be used per zone.

The length of each loop shall not exceed more than 1500 m. System shall have facility to calculate the requirement towards battery capacity / loop length using Loop battery calculator.

The automatic fire alarm and detection system shall consists of fire detectors and manual call points connected by appropriate cables to sector/ zonal panels which in turn shall be connected to the control and indicating equipment/ panel.

All proposed devices for fire alarm system shall be incorporated with the existing Addressable Fire Alarm System. Also the existing SU-30 Flight Hangar (099 Shop) shall also be included for installation of the automatic addressable fire detection system along with the other proposed locations.

The addressable fire alarm system shall consists of addressable devices and suitable control panel, zoning and number of detectors shall be as per Para No. 4.2.4 of IS : 2189-2008.

For ease of communication and synchronization of effort after activation of the fire alarm and detection system a convenient number of easily identifiable sectors/ zones, which the building shall be divided and fixed.

Proper protection/ shelter to be provided for any fire panel, MCP or other equipments which are liable to be exposed to rain, heat, etc.

A 12AH, 12 V/24V battery/ Standby power supply for at least 48 hours (including 30 minutes in alarm condition) with each Control panel, whichever is higher and 30 VA UPS on fully load condition shall be supplied.

The standby power supply unit with advance features i.e., dry battery backup, battery performance indicator, auto charger and protection system (short circuit, open voltage and deep voltage) shall be provided with the system.

All electrical cables shall be Armored type of standard make & quality only. If any cable passing through/ near any hot surfaces, vibration, friction etc the proper protection to cable shall be made.

Wiring diagrams for understanding the installation of detectors showing at least two detectors in connection and instructions for testing, and maintenance shall be supplied with the detector.

Description of circuit operation under normal alarm and fault condition and to detectors in dismantled/ unassembled form shall also be submitted.

Engineering drawings together with other relevant details of design and material used shall be submitted which define the product.

If any cable needs to be laid underground, the same shall be laid with sufficient protection i.e. inside the metal pipes etc.

Fault isolator module shall be fitted with group of detectors to protect against wire to wire short circuits on the system.
4.1 **FIRE ALARM CONTROL PANEL (FACP):**

This refers to the microprocessor-based panel that shall be connected to the various detector/devices by means of 2 wire loops. The FACP shall be able to identify individual detectors for performance as well as to give pinpoint location of fire alarm. Hooter Alarm as well as facility for cutting off of AHUs and electrical power is also to be included.

Addressable fire alarm control panel shall be expandable type with at least 80 character LCD display with back-light & alphanumeric keypad for programming shall be provided.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time –of-day basis.

The system shall be easily configured using ‘plug-in’ addressable loop cards and communication modules. The serial communication module shall allow serial communication for networking and peripherals.

The fire alarm panel shall have built-in networking feature to communicate on LAN using TCP/IP Ethernet converter module / interface.

The fire alarm control panel shall meet EN54 / UL standards.

The control panel of fire alarm system shall have features like LCD display, keypad, loop card, autodialing facilities, direct & EPABX lime simultaneously, other advance features like zone scanning facilities, event recorder, deep discharge protection, testing facilities, manual testing facilities, fire / fault detection, and other features

LED’s shall be provided for fire/ fault visual annunciation on the panel front. LED shall also be provided for power supply healthy, battery backup ON, battery / Charger status, and other features.

**SYSTEM CIRCUIT SUPERVISION**

The FACP shall supervise all circuits to intelligent devices, annunciators and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding.

The FACP shall have the facility for connection of operation of other fire fighting system through control modules if required.

The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equators, or annunciator programming/information.

It shall be possible to program through the standard FACP keyboard all system functions.

FACP shall supervise the connection between itself and repeater panel, providing the integrity of the cabling and indicating faults both on the repeater and FACP.

All field-defined programs shall be stored in non-volatile memory.

4.3 **ENCLOSURE:**

(iv) The control panel shall be housed in a cabinet suitable for surface or semi flush mounting. The cabinet and front shall be corrosion protected, give a rust-resistant prime coat, and manufacturers standard finish.

(v) The back box and door shall be constructed with provisions for electrical conduit connections into the sides and top/bottom.
(vi) The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.

(vii) The control unit shall be modular in structure for ease of installation, maintenance and future expansion.

4.4 **POWER SUPPLY:**

11.6.2 The FACP shall operate on 240 VAC, 50 Hz, +/-1 0% voltage tolerance.

11.6.3 The panel shall have in built battery back up and incase of main power supply fails, these batteries should automatically take over the system thereby monitoring 48 hours (including 30 mins in alarm condition).

11.7 **CABLES**

4.5.1 The materials covered by this specification shall unless otherwise stated as designed, constructed, manufactured and tested in accordance with latest revisions of the relevant Indian Standards:

- IS 1554 (Part I) 1976: PVC insulated cables for working voltages Up to and including 1100 V.
- IS5831 1970: PVC insulation and sheath of electric cables.
- IS8130 1984: Conductors for insulated electrical cables.
- IS 3961 (Part II) 1977: Recommended current ratings for PVC insulated and PVC sheathed heavy duty cables.

1. The cable shall be rated for a voltage rating of at least 1100 Volts.

2. Cables shall be selected considering the conditions of maximum connected load, ambient temperature, grouping factor, allowance voltage drops. However it is the responsibility of the contractor to recheck the sizes before cables are procured and connected.

3. The conductor shall be insulated with suitably compounded PVC applied to the conductor by the extrusion.

11.8 **LOOP:**

11.8.2 A loop shall mean a 2-wire circuit connecting minimum of 198 addressable devices (detectors and modules). The loop card shall have built-in short circuit isolators to accommodate class A wiring. Loop driver card shall be plug-in type and shall allow control panel to support input/output point from the addressable devices. Also it shall continuously monitor the values of all sensors and display this value on the panel.

11.8.3 The last device in each loop shall be provided with end of line resistor of suitable value as per circuit design to facilitate cable open circuit and short circuit detection.

11.8.4 The loop control module shall contain its own microprocessor and shall be capable of operating in a local/ degrade mode (any addressable device input shall be capable off activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

11.8.5 The loop control module shall provide power and communicate with all intelligent addressable detectors and module on a single pair of wires. This loop control module shall be capable of operating as Class A / B type wiring.

11.9 **CENTRALISED MONITORING STATION (GRAPHIC WORK STATION):**

11.9.2 A Personal Computer / software based centralized monitoring panel/ Video Display Unit (VDU) shall be installed at Main Fire Station.
11.9.3 Necessary data from various local control panel installed at various shops shall be taken with the existing LAN/WAN connection.

11.9.4 The necessary display for the monitoring shall be LCD/TFT type. The size of display shall be enough to observe the complete layout of the Fire Alarm systems easily with total clarity.

11.9.5 Necessary customized software to operate the complete system shall be provided along with the system.

11.9.6 Layout drawing of each fire alarm system installed at various shops/ hangars shall be displayed on graphic alarm management software.

11.9.7 All the features like fire/ fault/ serviceability status of various detectors and devices shall be incorporated in the required operating software.

11.9.8 In case of any emergency the respective detectors shall display the necessary signal regarding the same with both visible and audible signal.

11.9.9 Main Fire station shall have facility to have full (100%) monitoring & control of each device installed on the new FDA system & the FACPs using the Graphic alarm management software.

11.9.10 The required infrastructure to accommodate the above requirements at Main Fire station shall be provided.

11.9.11 A suitable power supply to the Video display unit shall be provided. (240V, 1 Ph, 50 Hz AC supply).

11.9.12 The standby power supply unit with advanced features i.e., dry battery backup, battery performance indicator, auto charger and protection system (short circuit, open voltage and deep voltage) shall be provided with the system.

11.9.13 The new central monitoring system shall also be integrated with existing addressable systems (Make-Notifier), which is located at Non Echo Chambers (096 & 099 Shop). The status report from these existing systems shall be taken at Main Fire Station.

11.9.14 The Video Display Unit (VDU) shall be the primary operator for data retrieval, alarm annunciation, commands and programming functions.

11.9.15 The VDU screen shall also have dedicated areas for the following functions like Alarm and return to normal, Commands, reports and programming, Time, day and date.

11.9.16 Alarms and all other, change of status shall be displayed in the screen area reserved for the information. Upon receipt of alarm, an audible shall sound and the condition and point type shall flash until acknowledged by the operator.

11.9.17 The system shall provide memory so that no alarm be lost.

11.9.18 Multiple levels of access to the system shall be provided for operators and supervisors via user defined passwords.

12 **DETECTORS**

(g) The detectors shall be addressable type. The chamber should be easily removable for the purpose of easy maintenance.

(h) The address programming shall be done by a handheld programmer / FACP.

(i) Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.

(j) The detectors shall have a common base to allow easy interchange of various types of detectors. The detectors shall be listed by LPCB / UL and meeting the calibrated sensitivity test requirements.
(k) Address setting shall be done using rotary switch.

(i) **ADDRESSABLE SMOKE DETECTORS:**

(m) The photo-electronic optical smoke detector shall be suitable for detecting visible smoke such as produced by slow smoldering fire.

(n) They shall be of the light scattering type using a pulsed internal LED light source and a photocell sensor.

(o) The detector shall be capable of protecting an area up to 80 Sq mtrs at a height of up to 12 mtrs.

(p) The technical specification for smoke detectors shall be as per relevant standards.

(q) A visual indication on normal condition when provided shall be visible from a distance of 6 M.

(r) A visual indication of detector’s alarm condition shall be provided which shall be visible from a distance of 6 M and shall be visually different from the indications of other conditions.

(s) Failure of any indicator lamp shall not prevent the detector from emitting fire signal indicating the existence of fire.

(t) Where separate bases are designed for mounting the detectors, means shall be provided to prevent incorrect alignment and/or incorrect connections of the detector by adopting plugging type systems.

(u) Terminals for external wire shall be provided which shall allow connections of conductor having normal cross-sectional area between 0.92 and 2.5 mm$^2$.

(v) Terminals shall rigidly clamp the conductor between metal surfaces with moderate contact pressure and without damage to the conductor. Disconnection shall be possible only with the help of tools.

(w) The current carrying parts shall not be exposed to unintended contact.

(x) There shall be no electrical and mechanical malfunctioning of the detector.

(y) The ratio of highest r.t.v (response threshold value) and lowest r.t.v. shall not exceed 1.6 and the lowest r.t.v. shall not be less than 0.05 dB/m.

(z) The detector shall meet the performance test and criteria for conformity as per EN54 / IS 11360-1985/ NFPA 71/72/ other relevant IS.

(aa) The detectors shall be approved make of IS/UL/FM/VDS/LPCB or equivalent standard.

7. **BEAM DETECTORS**

(xiv) This detector working on the principle of light obscuration shall be capable of responding to both smoldering fires and flaming fires. The sensitivity shall be such as to enable operation at 30% to 50% obscuration.

(xv) The detectors shall be designed such that in case of complete blocking of light beam it gives rise to trouble signal and not a fire alarm.

(xvi) The detectors shall be designed such that the small angular movement of the light source or receiver does not effect the operation of the detector and does not give rise to false alarm.

(xvii) The FLP beam detector shall consist of units such as a transmitter emitting pulse beam of infrared light rays, which is optically coupled to a photosensitive receiver and reflector on the other end.

(xviii) When the beam of infrared light is attenuated by smoke or air’s refraction index is changed, the electronic circuit of the detector gives signal for fire alarm.
The detector unit shall have combined transmitter/receiver unit that can be directly connected to a loop circuit.

It shall not generate false alarms due to dust build up or due to total obstruction.

The detector shall have built in automatic gain control to compensate for signal deterioration due to dust build up on the optical surface.

The detector shall have a detection range of 10 – 70m.

The detectors shall have LED's for normal, alarm & fault status indications.

The detectors shall be supplied with all the required mounting brackets for wall, ceiling, truss mounting etc.

The beam detector shall be a loop powered unit and shall get supply directly from panel.

The detector shall have relays for alarm and fault, which shall be monitored by fire alarm panel.

Transmitters, receivers and/or reflectors shall be mounted on a solid and stable construction which shall withstand vibrations, temperatures or any imposed load.

FLP enclosures for beam detector shall be supplied.

The beam Detector shall be Approved from IS/U L/FM/VDS/LPCB or equivalent standard.

8. ADDRESSABLE HEAT DETECTORS

9.7 Heat detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute.

9.8 The addressable heat detectors shall be connected via two wires to the fire alarm control panel signaling line circuit.

9.9 The detectors shall provide an alarm and power LED.

9.10 The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel.

9.11 The LED shall be placed into steady illumination by the control panel indicating that an alarm condition has been detected.

9. ADDRESSABLE MULTISENSOR DETECTOR

a) The detectors shall combine photoelectric and thermal sensing technologies to increase immunity to false alarm principal to measure smoke density.

b) The addressable multisensor detectors shall be in position to work in advance multi Sensing, on command from the control panel, send data to the panel representing the analog level of smoke density with automatically adjust sensitivity levels without out the need for operator intervention or programming. Sensitivity increases with heat.

c) The detectors shall provide an alarm and power LED.

d) The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel.

e) Also the LED shall be placed into steady illumination by the control panel indicating that an alarm condition has been detected.

10. MANUAL CALL POINT:

The manual call point shall be fully addressable type (without using module) to define the station. The overall size of the MCP shall not exceed 100 mm X 100 mm X 60 mm.
g) The MCP shall consist of an enclosure, with a captive glass pane, and it shall incorporate an addressable communications module. Breaking the pane shall initiate an alarm. No secondary action shall be required by the operator.

h) The call point shall incorporate a plastic-laminated safety glass which will not produce sharp edges when broken, thereby protecting the operator from injury.

i) An externally visible LED must be incorporated to indicate when the device is in alarm. The LED shall illuminate when the call point is activated. However, the illumination of the LED will be by command from the control panel.

j) The Manual call points of standard make to be provided inside and outside the shops with fire red colour (Shade 536 of IS-5) epoxy painting, weather proof and inscription of “Break Glass in case of Fire”.

k) A suitable nickel-plated brass hammer duly chained to the box with stainless steel chain shall be provided with each box for breaking the glass.

l) The glass surface shall be minimum 30 cm² in area and glass thickness shall not exceed 2 mm.

m) Once the glass is broken the alarm shall sound on the floor as well as on the control and indicating equipments and light shall glow to indicate its operation.

n) The alarm shall be maintained by the control and indicating equipment even if someone presses the button subsequently.

o) The MCP shall be Approved from IS/UL/FM/VDS/LPCB or equivalent standard.

11. FLASHING LIGHTS (BEACON)

(k) Strobe / Beacon shall be addressable loop powered and shall provide visual indications towards fire/ alarm warning.

(ℓ) The unit shall consist of solid-state circuitry on a printed circuit board and a red-capped incandescent lamp and audio housed in a dust tight, wall/ ceiling mounting type enclosure. It shall derive power from the fire alarm control panel and shall operate on DC supply.

(m) Flashing lights shall be installed in the enclosed areas. In the event of signal, the lamp shall start blinking with a warning sound enabling operating personnel to evacuate the area.

(n) The Flashing lights shall be approved from IS/UL/FM/VDS/LPCB or equivalent standard.

12. HOOTER / SOUNDER

(ix) The Sounder / Hooter shall be addressable loop powered with high sound output and shall be designed to simplify installation, including terminals for both in and outgoing cables and an earth termination for cable screens.

(x) Electronic components in the sounder shall be protected by a cover to prevent damage during installation.

(xi) Hooter of 0.5 Kms audible range shall be installed inside and outside of the shop.

(xii) Hooter shall be horizontal single mounting.

(xiii) The unit shall be powered from fire alarm panel.

(xiv) In the event of fire, the hooter shall raise pulsating audio alarms and lamps shall start flashing.

(xv) The sounders for fire alarm shall be electronic hooter having a frequency range of 500 to 1000 Hz.

(xvi) The sound of the fire alarm shall be continuous although the frequency or amplitude may vary.
The distribution of the hooter shall be such that the alarm shall be heard at all site which can be occupied within the protected area.

13. **FIRE ALARM TESTING**:

7. The FACP shall be checked for basic tests such as visually checking input voltage and amperage. All zones one by one shall be de wired to check for fault signal indication in the FACP.

8. The power source shall be cut off and checked for stand by supply from the batteries. After six hours the FACP source shall be switched on to check for auto switch over to the mains mode.

9. Test shall be conducted for AC fail, charger fail, DC fail, battery disconnect or battery fail. In all such cases the relevant LED should glow and the piezo sound shall also give sound output.

10. The addressable fire alarm system shall be tested as per the following scheduled. Additional testing, as decided by the owner shall also be carried out by the bidder.

11. Testing of Fire alarm system shall be carried out as mentioned in IS/UL/FM/VDS/LPCB or equivalent standard.

14. **PHOTOELECTRIC TYPE SMOKE DETECTOR**:

(v) The testing shall be carried out for each loop / zone, initially one detector in a zone and subsequently 2 or more disassociated detectors in each zone with time lapse between the detectors to test for alarm priority, alarm queuing and call logging.

(w) Identified detectors will be subjected to smoke aspiration from burning paper/cigarette puffs, rubber and other materials which gives dense smoke held at 0.3 m distance from the detector. The FACP should indicate increased analogue output for that address and after the programmed delay time, a fire alarm signal shall be indicated. This delay shall be utilized for alarm verification.

(e) The same test shall be carried out for two detectors in the same loop but in different rooms. The FACP shall indicate pre alarm higher analogue levels for both detectors in its display with separate identification for both fires. One of the detectors in question be subjected to higher and longer levels of smoke aspiration. The FACP should give priority alarm for this address. The printout shall indicates individual addresses of the detectors with achieved analogue values and the time of event.

(f) This test shall be carried out for different loops as well as for 2 loops simultaneously.

15. **ADDITIONAL TEST**:

8. One detector of each type will be disconnected and subjected to slow dust build-up by means as desired by the bidder and again connected in the circuit.

9. The FACP shall indicate the changes ambient level and automatically adjust with analogue values for the same. These detectors shall then be replaced by new detectors of identical type and the FACP shall then be programmed accordingly and checked. The bidder will take custody of the removed detectors without additional cost to the owner.

10. Any part of the loop shall be short-circuited. The FACP shall indicate the communication failure of all the devices connected to the short-circuited segment. After the short circuit is corrected, the fault isolator shall return to its normal status automatically, this being reflected in the FACP. The loop shall then be in normal operation again. Any part of the loop shall be de wired and tested as given above.

**SIGNATURE OF TENDERER WITH SEAL**

**EMPLOYER**

d All other tests as required by the client at the time of handing over.

16. **FINAL INSPECTION**:

At the final inspection a contractor shall provide a factory trained representative the manufacturer of the major equipment shall demonstrate that the system function properly in every respect.
17. INSTRUCTION:

9. Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system component and the entire system including program changes and functions shall be provided.

10. The contractor and/or the system manufacturer’s representatives shall provide a typewritten sequence of operation.

18. MAINTENANCE:

10.1. The maintenance of Fire alarm systems during warranty period is solely responsibility of the vendor. Vendor need to provide activity chart giving details of schedule of preventative maintenance of the system for each year.

10.2. Minimum of 6 nos. of visit per year (once in 2 months) towards preventive maintenance shall be required. Vendor to attend to complaint within 36 – 48 Hours of being reported.

Detailed operation and maintenance manual in duplicate shall be supplied

TECHNICAL SPECIFICATIONS FOR FIRST AID FIRE EXTINGUISHERS

Work under this section shall consist of furnishing all labor material appliances and equipment necessary and required to install fire extinguishing hand appliances.

The vendor shall install and commission the portable Fire extinguishers as per tender drawing.

Without restricting to the generality of the foregoing, the work shall consist of the following.

GENERAL REQUIREMENTS:

Fire Extinguishers shall conform to the following Indian Standard specifications as revised and amended up to date.

Dry Powder Type : IS: 2171-1962
Carbon Di-oxide : IS: 2878/1976
Mech Foam type : IS: 10204


The appliances shall be installed in readily accessible locations with the appliances brackets fixed to wall by suitable anchor fasteners.

Generally, fire extinguishers should be placed as near as possible to exits or stair lands without hindering the escape routes. Wherever possible, advantage should be taken of normal routes of escape by placing these in positions where these shall readily be seen by persons following the natural impulse to get out of danger.

Wall mounted fire extinguishers should be placed on the supporting wall or in wooden, metal or plastic cabinets in such a way that their 1000 mm bottom is above ground level. When installed in the open, fire extinguishers should be placed on masonry platforms or in wooden/metal/plastic cabinets in such a way that their bottom is 1 000 mm above ground level.

Operating instructions shall be provided and mounted in a brushed stainless steel frame with a clear plastic cover adjacent to the control panel. The instructions shall include the following:

- Procedure to follow when fire is detected.

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER
How to reset and test the entire system after trouble or fire is detected.

Location and type of extinguishers as per drawing

TECHNICAL SPECIFICATION FOR FIRE EXTINGUISHERS

(n) DCP EXTINGUISHER (CARTRIDGE TYPE) CAPACITY :5 Kgs,

(xi) Dry Chemical Powder type fire extinguisher,
(xii) Complete with gunmetal cap, bracket
(xiii) Initial charge of 5,10 kgs. Sodium- bi-carbonate base dry chemical powder.
(xiv) Dry chemical powder bearing ISI mark IS: 4308
(xv) Fully charged 120,200 gms CO2 gas cartridge. Gas cartridge bearing ISI mark IS: 4947
(xvi) Fitted with 55 cms long discharge hose with open type nozzle.
(xvii) Extinguisher bearing ISI mark IS: 2171.
(xviii) MS body Cap as per IS : 318 MS
(xix) Siphon tube as per IS: 3601.
(xx) Filled weight of extinguisher 11.5 Kgs.
(xxi) Tested to 30 Kgf/cm$^2$ for 2 minutes.
(xxii) Supplier to attach test certificate

(o) DCP EXTINGUISHER (ABC Powder type) CAPACITY :5 Kgs

(xxxi) Dry Chemical Powder (ABC) type fire extinguisher,
(xxiv) Complete with gunmetal cap, bracket
(xxv) Initial charge of 5,10 kgs. Sodium- bi-carbonate base dry chemical powder.
(xxvi) Dry chemical powder bearing ISI mark IS: 4308
(xxvii) Fully charged 120,200 gms CO2 gas cartridge. Gas cartridge bearing ISI mark IS: 4947
(xxviii) Fitted with 55 cms long discharge hose with open type nozzle.
(xxix) Extinguisher bearing ISI mark IS: 2171.
( xxx) MS body Cap as per IS : 318 MS
( xxi) Siphon tube as per IS: 3601.
( xxxii) Filled weight of extinguisher 11.5 Kgs.
( xxxiii) Tested to 30 Kgf/cm$^2$ for 2 minutes.
( xxxiv) Supplier to attach test certificate

13.6 MECHANICAL FOAM (AFFF) TYPE FIRE EXTINGUISHERS (CAP 9LTRS),

Aqueous Film Forming Foam (AFFF) Mechanical foam type extinguishers
9. Capacity of fire extinguisher: 9 lttrs.,
10. Complete with gunmetal cap. Bracket, fitted with flexible hose terminating in a foam branch pipe
12. 540 ml AFFF 6% charge bearing ISI mark.
14. The AFFF concentrate to be as per IS 4989 Part-2
15. Supplier to attach test certificate

4. CARBONDIOXIDE GAS BASED PORTABLE EXTINGUISHERS

Carbon dioxide Extinguishers [Capacity (2 KG)]

2. Capacity – 2 Kgs
3. Consisting of brand new high-pressure steel cylinder bearing IS 7285
4. Approval of Chief Controller of Explosives, Nagpur
5. Wheel type valve bearing IS 3224
6. CO2 gas as per IS: 307
7. Internal discharge tube IS: 738
8. **Discharge duration 8-18 seconds.**

9. Filled weight of extinguisher 7.6 kgs tested to 236 Kgf/cm².

10. Suspension clips (installation bracket with nails)

11. Elbow type discharge hose (brass adaptor)

12. With washer

13. The extinguisher should be bearing IS 2878

14. Supplier to attach test certificate

**ii) Carbon dioxide Extinguishers [Capacity 4.5 KGS]**

6. CO2 type 4.5 kgs capacity fire extinguisher assembled from brand new CCE approved cylinders,

7. Internal discharge tube: IS: 738

8. One meter high-pressure rayon braided hose, discharge horn bearing.

9. The extinguisher should be bearing IS 2878.

10. CO2 cylinder as per IS 7285 CCE approved,

11. Wheel type valve bearing IS 3224

12. CO2 gas as per IS: 307,


14. Filled weight of extinguisher 17 Kgs tested to 236 Kgf/cm².

15. Supplier to attach test certificate

**iii) Carbon dioxide Extinguishers [Capacity : 6.8 KGs (Twin cylinder trolley mounted)]**

(w) Twin carbon dioxide (CO2) fire extinguishers of 6.8 kgs capacity each (i.e., 2 X 6.8 Kgs CO2 cylinder) Trolley mounted.

(x) Extinguisher confirming to IS: 2878.

(y) CO2 cylinder as per IS 7285 CCE approved

(z) Fitted with high pressure flexible rubber discharge hose 12 mm dia. X 9 meters long with common manifold, with puncturing device connected with discharge hold

(aa) Complete set manufactured to IS : 8149/1 976 and mounted on a trolley.

(bb) The applicator to be extended type with telescopic arrangement.

(cc) Supplier to attach test certificate

**iv) Carbon dioxide Extinguishers [Capacity : 45 Kgs (Twin cylinder hand held fire suppression system)]**

3. CO2 based hand held fire suppression system consisting of 2 Nos. high pressure 45 Kgs CO2 CCEO approved

4. Extinguishers confirming to IS: 2878.

5. Cylinder as per IS-7285 with brass discharge head connected to a common brass discharge head connected to a common manifold pipe confirming to ASTM a 106 GR-B SCH-80 by 3/4” inch high pressure,

6. Flexible wire reinforced rubber discharge hose,

7. 30 metre long hose reel

8. Painted red wound in a MS rotating hose drum connecting to horn and valve assembly complete with safety relief valve, cylinder rack and MS continuous strap.

9. The applicator to be extended type with telescopic arrangement.

10. Supplier to attach test certificate.

**Technical specification for Water Mist system (Trolley mounted, Capacity – Minimum 50 Ltrs)**

349 **SCOPE OF SUPPLY:**

The Minimum of 50 Litre capacity water mist system trolley mounted with water mist gun of discharging both jet and spray is proposed to be placed at different Aircraft Hangers. The scope of supply cover complete installation and testing of the system.

350 **GENERAL REQUIREMENTS:**
The system shall be operated manually.

The contractor/supplier shall submit 4 sets of manuals consisting of design of water mist system trolley mounted, list of spare parts with part numbers, SOPs, Preventive maintenance, Periodic Servicing, Sources of Suppliers for spare parts, etc.

Vendors shall attach list of the parties already supplied. Vendor shall also submit the performance report of the same.

Vendors shall ensure availability of spare parts and maintenance support services for the offered system for at least 10 years from the date of supply.

Party shall serve the warranty/guarantee period for at least 2 years from the date of supply and testing.

Initial expenditure for testing the system shall be born by the party.

Test certificate, manuals and other relevant documents to be submitted.

The supplier shall conduct training for Standard Operation Procedure (SOP’s), routine maintenance and major repairing of the system at HAL site of the proposed system on free cost at HAL site at the time of supply.

Party shall submit the point wise compliance report for all the requirements specified and deviations if any as per under mentioned format.

Vendor shall quote the systems with MAKE & Model No of the equipments.

Any damage while transporting the system for supply and before handing over to HAL Fire services will be whole responsibility of the supplier. The cost for any damage shall born by the supplier.

The contractor shall supply 4 sets of drawing of the complete and finally approved installations for owner’s use and records.

The water mist system shall be as per EN 1866/ IS/ NFPA/ UL//FM/VDS/LPCB or equivalent standards.

The system shall consist main container/vessel, compressed air cylinder, discharge tube, discharge gun, pressure gauge, safety valve, connecting metal pipes, trolley with suitable wheels, carrying handles, necessary straps for holding Air cylinder, arrangement for coiling discharge hose & discharge gun etc.

The operating pressure of the proposed system shall be minimum 7 bar pressure.

The system shall be capable of carrying 50 Liters (Minimum) of water in the main vessel.

The contained of vessel shall be expelled by air pressure with the help of air cylinder of capacity of minimum 6 litres & pressure of 200-300 bar.

The air cylinder shall be approved by CCE/ PESO.

The air cylinder shall be capable for the discharge of fine water mist through discharge gun.

The system shall be suitable to A & B class of fire & also live electrical fire.

The system shall be able to recharge quickly without cleaning with much maintenance so as to be ready for use for any fire emergency.

The main container/vessel of the proposed water mist fire fighting system shall be made of...
361 Pressure gauge on top of the main vessel/container and/or air cylinder shall be provided.

362 Discharge gun shall not be more than 2.0 Kgs.

363 The fire-fighting agent shall have the mixtures of water and AFFF foam.

364 Carbon composite Compressed/ seamless carbon steel air cylinder shall have rating of at least 6 ltrs & pressure of 200-300 bar to be used for discharge of 50 ltrs solution with full power.

365 The design of the gun shall be such that there is no recoil pressure during operation and shall have the locking system to avoid misuse.

366 The system shall be provided with a safety valve/device considering the design criteria of the system.

367 The system shall be compatible to be used with the bigger cylinders of the capacity of 6 ltr and above water capacity for longer duration operation.

368 The system shall be suitable to fight live electric fires.

369 The system shall be able to release droplets size between 200 to 400 micron, which in turn shall provide more kinetic energy effective operation. It shall maintain constant pressure during whole operation.

370 The system shall be clean automatically as the remaining air is blown out of the container and system shall be ready for quick second recharge. Shall work as effectively even air in the cylinder is as low as 40 to 50 bar. The system shall be recharged two or three times with same pressure bottle.

371 The acceleration in the system shall be done through operating air pressure.

372 Operating temp. shall be within -50° C to 70° C. The system shall be able to be stored both in upright as well as flat condition.

373 The extinguishing agent used should not cause deposit in the container.

374 Any type of available water such as sea water, dirty water can be used in the container without effecting the operation.

375 Stream of the jet shall be required by user itself controlled at pressing the trigger of the gun.

376 The water container shall be mounted on 2 wheel trolley as per EN 3-7 standard which shall accommodate air cylinder, hose reel (Discharge tube) and discharge gun. Wheel diameter of the trolley shall be less than or equal to 700 mm, tubeless tyres and frame shall have shock absorber. The trolley shall be easily carried on rough terrain. The suitable carrying handle shall be provided with the trolley. The design of the trolley shall be suitable for best maneuvering in case of fire. The trolley shall be made of preferably of M.S. painted with epoxy paint fire red as per IS. The fire fighting system mounted on trolley shall be carried easily from one spot to other in case of emergency by single person.

377 The direction of opening/closing of filling cap in main vessel shall be clearly marked.

378 The provision for releasing of the air pressure shall have incorporated in the system to neutralize the main vessel pressure after use.

A good quality and reputed brand Pressure gauge shall be provided for measuring the pressure of compressed air of the cylinder.
The main container/vessel shall be painted by the enamel fire red paint.

The PVC sticker with Name of the equipment, Operating instruction, suitability over class of fire, Make/Model, year of manufacturing, name of manufacture etc. shall be sticked on the main vessel. The backpack assembly shall be comfortable and easy to wear by the Fireman.

The extinguishing media shall be mixture of water and 6% Aqueous Film Forming Foam Conc.(AFFF).

The main container shall be provided with the safety valve which will be operated / actuated automatically.

The working / operating pressure of the system shall be designed in such a manner that the performance of the system shall meet the criteria.

The Discharge tube shall be high pressure armored rubberized hose of the length minimum 5 meters.

The discharge tube shall be externally protected with the metal spring coil.

The compressed air cylinder shall be made by carbon fiber / composites which must be approved by the CCE/PESO, Nagpur.

The capacity of the air cylinder shall not be less than 06 liters at minimum 300/200 bar pressure.

The all details of the cylinder like cylinder Srl.No, year of manufacturing, date of hydraulic testing etc shall be provided.

The Adopter assembly of cylinder shall be as similar as air cylinder of the Standard Breathing Apparatus Set.

The discharge gun shall be so designed that there shall be no backpressure / hammer effect or any jerk to the user during pressure. The gun shall be easy to operate by the user.

The gun shall be made by Stainless Steel with the pistol grip handle with provision to avoid any electrical shock.

The complete water mist gun shall be light in weight.

The discharge gun shall have the feature of ‘jet and spray’ mode both for discharge of extinguishing media.

All metal parts (excluding SS) which come in direct contact with the foam solution shall be properly plated / coated with anticorrosive material with sufficient thickness.

**PERFORMANCE REQUIREMENT:**

The water mist fire fighting system shall meet the following performance characteristics:

4.1 The discharge rate shall be within 24 to 35 ltrs per minute

4.2 The droplet size of the water mist produced by the system shall be between 200 to 400 microns.

\( (m) \) The lancing distance shall be from 9 to 18 meters in jet mode and 4 to 8 Meters in spray form.

5 **STANDARD ACCESSORIES/SPARE PARTS:**

Standard accessories/spare parts to be supplied with the system:

Compressed Air Cylinder of the minimum 6 Liters at pressure 300/200 bar – 01 No.

Delivery hose of minimum 5 meters length with suitable adopters - 01 No.
5.3 AFFF (6%, UL Approved) Foam Conc. in PVC Jerry can - 100 Liters.

5.4 PVC Mug with PVC funnels for measuring AFFF - One Set

5.5 Filters for Extinguishing Media - 02 Nos.

5.6 Standard Tool Kit suitable to the system - One Set

5.7 Filling cap ‘O’ Rubber Ring – 10 Nos.

**LIST OF APPROVED MAKES**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPES &amp; FITTINGS</td>
<td></td>
</tr>
<tr>
<td>G.I Pipes/Fittings</td>
<td>Jindal / Tata</td>
</tr>
<tr>
<td>G.I Fittings</td>
<td>VS/JK</td>
</tr>
<tr>
<td>Paint</td>
<td>Berger / Asian/J&amp;N</td>
</tr>
<tr>
<td>Paint Primer</td>
<td>Asian/Jenson Nicholson/Burger</td>
</tr>
<tr>
<td>HYDRANT SYSTEM</td>
<td></td>
</tr>
<tr>
<td>Gun metal valves</td>
<td>Zoloto/Leader/Kalpana</td>
</tr>
<tr>
<td>Butterfly valves</td>
<td>H.sarker/Kirlosker/upadyaya/Kalpana</td>
</tr>
<tr>
<td>Wrapping &amp; Coating tape</td>
<td>IWL</td>
</tr>
<tr>
<td>Hydrant valves &amp; accessories</td>
<td>Newage/Winco/Zenith/Minimax</td>
</tr>
<tr>
<td>Hose pipes</td>
<td>Newage /Winco/Dunlop</td>
</tr>
<tr>
<td>Air relase valve</td>
<td>PN Kirloskar/H sarkar/Upadhyaya</td>
</tr>
<tr>
<td>Rubber pipe for Hose reel</td>
<td>Denlop/Newage</td>
</tr>
<tr>
<td>FIRE EXTINGUISHERS SYSTEM</td>
<td></td>
</tr>
<tr>
<td>Fire Extinguishers</td>
<td>Newage/Safex/Zenith/Minimax</td>
</tr>
<tr>
<td>Water Mist Fire Fighting</td>
<td>ASKA/H NE/AFT</td>
</tr>
<tr>
<td>System</td>
<td></td>
</tr>
<tr>
<td>FIRE DETECTION &amp; ALARM SYSTEM</td>
<td></td>
</tr>
<tr>
<td>Detectors</td>
<td>Morley/Notifier/Siemens/Edwards/Zicom</td>
</tr>
<tr>
<td>Control Panel</td>
<td></td>
</tr>
<tr>
<td>MCP</td>
<td></td>
</tr>
<tr>
<td>Electronic Hooters</td>
<td></td>
</tr>
<tr>
<td>Response Indicators</td>
<td></td>
</tr>
<tr>
<td>Control modules</td>
<td></td>
</tr>
<tr>
<td>Monitor module</td>
<td></td>
</tr>
<tr>
<td>Conduit pipes/accessories</td>
<td>BI/Gupta (Metallic)</td>
</tr>
<tr>
<td>Power/control Cables</td>
<td>Varsha/policab/Excel</td>
</tr>
</tbody>
</table>

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER

SIGNATURE OF TENDERER WITH SEAL

EMPLOYER